NATIONAL BUREAU OF STANDARDS HANDBOOK 44—2d EDITION 1955

SPECIFICATIONS, TOLERANCES, AND REGULATIONS FOR COMMERCIAL WEIGHING AND MEASURING DEVICES

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Superseding Handbook 44—1949

SPECIFICATIONS, TOLERANCES, AND REGULATIONS FOR COMMERCIAL WEIGHING AND MEASURING DEVICES

ADOPTED BY THE

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

U. S. DEPARTMENT OF COMMERCE • Sinclair Weeks, Secretary

NATIONAL BUREAU OF STANDARDS • A. V. Astin, Director

Issued July 15, 1955

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D.C. - Price, Buckram $2; Loose Leaf $1.

HOW TO USE THIS HANDBOOK

1. Consult table of contents, pages IV to VI, to locate major subdivisions of entire text.
2. Observe running heads throughout, for major subdivisions of entire text.
3. Consult alphabetical index of definitions, beginning on page 153, to locate all terms formally defined in the several codes of specifications, tolerances, and regulations.
4. Consult sequential paragraph index, beginning on page 163, to locate, by code and paragraph designation and side title, the sections and paragraphs of the several codes of specifications, tolerances, and regulations.
5. Consult appendix for:
   (a) Tables of weights and measures, beginning on page 181.
   (b) Tables of interrelation among weights and measures units, beginning on page 186.
   (c) Tables of weights and measures equivalents, beginning on page 191.

PREFACE

This Handbook supersedes National Bureau of Standards Handbook 44, published in 1949, and presents a complete revision of the specifications, tolerances, and regulations for commercial weighing and measuring devices of the National Conference on Weights and Measures. This revision was developed by the Conference Committee on Specifications and Tolerances in cooperation with the Office of Weights and Measures of the Bureau, and was adopted by the 40th National Conference in 1955. These codes are recommended by the National Bureau of Standards for promulgation by the States.

A. V. Astin,
Director, National Bureau of Standards.

NOTE

For the loose-leaf copies of this Handbook, Replacement Sheets, corrected to show amendments or additions made by the National Conference on Weights and Measures subsequent to 1955, will be individually dated to show the year or years in which the changes incorporated in them were made by the National Conference. However, in the original printing, the loose-leaf sheets corresponding to pages of the bound copies are not dated.

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SPECIFICATIONS, TOLERANCES, AND REGULATIONS

FOR

COMMERCIAL WEIGHING AND MEASURING DEVICES

AS ADOPTED BY THE

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

AND RECOMMENDED BY THE

NATIONAL BUREAU OF STANDARDS FOR ADOPTION BY THE SEVERAL STATES

INTRODUCTION

SOURCE.—The specifications, tolerances, and regulations published herein comprise, in their latest form, all of the current codes as adopted by the National Conference on Weights and Measures,[1] the latest action reported having been taken by the Fortieth National Conference on Weights and Measures in 1955. The Conference Committee on Specifications and Tolerances,[2] acting at the request of the

[1] The National Conference on Weights and Measures is a body made up of State and local weights and measures officials from all parts of the United States, which normally meets annually at the National Bureau of Standards, Washington, D. C. For a more detailed description of the Conference and its activities, see chapter 12, National Bureau of Standards Handbook 26, Weights and Measures Administration. Inquiries regarding Handbook 26 may be addressed to Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C.

[2] A standing committee of the National Conference, consisting of five members. Communications to this committee may be addressed as follows: Secretary, Committee on Specifications and Tolerances, National Conference on Weights and Measures, c/o Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C.

Conference or upon its own initiative, prepares from time to time, with the cooperation of the National Bureau of Standards, proposed amendments or additions to the material previously adopted by the Conference; such amendments or additions are then presented to the Conference as a whole, where they are discussed by weights and measures officials and representatives of interested manufacturers and industries; eventually the proposals of the Committee, which may have been amended on the floor, are voted upon by the weights and measures officials, a majority vote being required for adoption.

It is the practice to adopt new codes tentatively, final action being deferred at least until the succeeding Conference; sometimes a code will retain its tentative status for a longer period. Major changes in existing codes are sometimes handled as in the case of new codes; at other times an important change in an existing code is regularly adopted but a future date is specified before which the change shall not be put into effect. Not infrequently the effective date for a major change in requirements—and sometimes for a new code—has been specified as a month or more subsequent to the dates for the succeeding meeting of the Conference in order to provide the opportunity for review and modification of the requirements and for changing the effective date.

All of the specifications, tolerances, and regulations given herein are recommended by the National Bureau of Standards for official promulgation in and use by the several States in exercising their control of commercial weighing and measuring apparatus; a similar recommendation is made with respect to the local jurisdictions within a State, in the absence of the promulgation of specifications, tolerances, and regulations by a State agency.

PURPOSE.—The purpose of specifications and tolerances is to eliminate from use, without prejudice to apparatus that conforms as closely as practicable to the official standards, weights and measures and weighing and measuring devices that are false, that are of such construction that they are faulty—that is, that are not reasonably permanent in their adjustment or will not repeat their indications correctly—or that facilitate the perpetration of fraud.

CLASSIFICATION OF SPECIFICATIONS.—The classification into "retroactive" and "nonretroactive" requirements is made in order that the requirements may be put into force and effect without unnecessary hardship and without whole-

sale condemnation of apparatus that, while not of the best construction, is nevertheless fairly satisfactory and may be used for some time without greatly prejudicing the rights of buyers and sellers. Nonretroactive specifications are those that, while clearly desirable, are not so vital that they should at once be enforced with respect to all apparatus.

It is not to be expected, however, that, after their promulgation in a given jurisdiction, nonretroactive specifications shall always remain nonretroactive. It is entirely proper that a weights and measures official, following a careful analysis of existing conditions, fix reasonable periods for the continuance of the nonretroactive application of particular specifications, at the expiration of which periods such specifications will be come retroactive in their application. These periods should be of such length as to avoid undue hardship on the owners of apparatus and, in the case of some specifications, should approximate the average useful life of the apparatus in question. The periods will, of course, differ for different apparatus, and may differ for different specifications in the same code. In order that all parties at interest may have timely and ample notice of impending changes in the status of specifications, the following procedure is suggested for the official who plans to change the classification of specifications: If sufficient data are at hand to make such action feasible, publish in combination with the codes themselves the date or dates at which nonretroactive specifications are to become retroactive. In other cases, give equally effective notice at the earliest practicable date.

In earlier compilations of the specifications published prior to 1949, the nonretroactive character of specifications originally so classified was retained, regardless of the time that may have elapsed since original adoption. This was done for the guidance of officials in jurisdictions about to inaugurate weights and measures supervision. In 1949 the character of many specifications was changed by the National Conference from nonretroactive to retroactive, in the belief that ample time had been allowed for the elimination, by obsolescence, of apparatus that it was originally expedient to exempt from these then nonretroactive requirements, and that ample time had also been allowed for equipment manufacturers to adjust fully to these requirements. In 1955 the National Conference again considered the appropriateness of the nonretroactive character of the requirements so designated, and a number of requirements previously in the

nonretroactive category were made retroactive in application. The amount of nonretroactive material shown herein conforms, therefore, to a current evaluation of what requirements should be newly promulgated as nonretroactive.

REVISED FORM OF CODES.—The form and texts of the codes of specifications, tolerances, and regulations were extensively revised by the National Conference on Weights and Measures in 1949 in an effort to clarify the meaning, simplify the language, eliminate repetition of requirements, present requirements in logical and uniform order, and establish a uniform elastic system for numerical identification of paragraphs. One feature of this revision was the establishment of a General Code, the requirements of which apply generally to all classes of weighing and measuring apparatus. Thus, to learn the requirements applicable to a particular class of apparatus, both the General Code, and the specific code for the class of apparatus in question, must be consulted.

In this edition of the Handbook the specifications, tolerances, and regulations are preceded by a discussion of certain fundamental considerations closely associated with the enforcement of these technical requirements. These sections parallel the treatment of these considerations already published as chapters 1, 2, and 3 of National Bureau of Standards Handbook 45, Testing of Measuring Equipment. Herein the discussion is broadened to relate to weighing, as well as to measuring, equipment, and recommendations are offered for effective procedures in relation to the promulgation and application of specifications, tolerances, and regulations and to the adjustment, rejection, and sealing of commercial equipment. These sections are commended for careful study.

It should also be noted that in this edition of the Handbook the order of presentation of the several codes has been changed. It is believed that the new arrangement will contribute to the convenience of those using the Handbook. In this arrangement the new index of definitions will be found immediately preceding the sequential index of side titles.

A further addition to the Handbook is a series of weights and measures tables. These comprise (1) general tables of weight and measure, (2) tables of interrelation of units of length, arae, volume, liquid measure, dry measure, and mass, and (3) tables of equivalents. These tables will be

found in the Appendix following the sequential index of side titles.

BOUND AND LOOSE-LEAF COPIES.—Handbook 44—2d Edition—1955 is published in two forms—as bound copies intended for library and other reference use, and as sets of punched "loose-leaf" sheets for insertion in a standard 8½ x 5½-in. three-ring binder to constitute "working copies" of the codes for office and field use.

In 1955 the membership of the National Conference Committee on Specifications and Tolerances comprised R. E. Meek of Indiana (Chairman), W. S. Bussey of the National Bureau of Standards (Secretary), Robert Williams of Nassau County, N. Y., J. E. Brenton of California, and H. E. Howard of Miami, Fla. (Mr. R. D. Thompson of Virginia was a member of the Committee in 1954, but left State employment early in 1955 and resigned from the Committee. He was succeeded on the Committee by Mr. Howard.) This Committee, with the cooperation and assistance of the Office of Weights and Measures of the Bureau, made a detailed study and analysis of the existing codes of specifications, tolerances, and regulations, and prepared a proposed revision thereof. This proposal was given wide circulation for comment by weights and measures officials and manufacturers of weighing and measuring devices. Later, open hearings were held by the Committee, prior to the convening of the 40th National Conference. Finally, through formal action by the 40th Conference, a complete revision of the codes was adopted.

In addition to numerous minor changes made in the interest of greater clarity and of uniformity of treatment and language but without change of meaning, numerous substantive changes and additions were made to the requirements. In four cases important changes in form were effected: The code for Taximeters and the code for Odometers were consolidated into a single code for Mileage-Measuring Devices; the code for Pre-Packaged-Ice-Cream Measure-Containers was incorporated into the code for Measure-Containers; the code for Grease-Measuring Devices was eliminated and appropriate requirements for lubricant-measuring devices were incorporated in the code for Liquid-Measuring Devices; and all appropriate meter requirements of the code for Liquid-Measuring Devices were duplicated in the code for Vehicle Tanks. A new section, "General Code References", was added at the beginning of each of the codes

for particular types of equipment, in order to make specific reference to relevant paragraphs of the General Code. Finally, there was prepared an alphabetical index to all terms formally defined in the "D" sections of the several codes.

CORRECTION AND REPLACEMENT SHEETS.—The National Bureau of Standards plans to issue, closely following each meeting of the National Conference on Weights and Measures at which code changes are adopted, "correction" sheets for bound copies and "replacement" sheets for loose-leaf copies of the Handbook. These correction and replacement sheets will deal only with the text of the specifications, tolerances, and regulations, and such sheets will not be issued with respect to the Index of Definitions and the Sequential Paragraph Index.

Correction sheets will be similar to those issued for Handbook 44—1949. Changes in and additions to Handbook text will be printed to conform with the Handbook text, and it will be clearly shown where the corrections are to be made. In most cases it will be found practicable to attach a portion or all of a correction sheet directly at that point in the original text where the correction is to be made, and this method of making corrections is recommended. In any event, each correction should be promptly inserted in the Handbook, and suitable notation should be made at the proper point directing attention to the amendment or addition.

A correct replacement sheet will be issued for each old loose-leaf sheet requiring one or more corrections. The replacement sheet is simply to be substituted for the old sheet.

Correction sheets and replacement sheets will be supplied without charge to holders of bound or loose-leaf copies of the Handbook. However, distribution of these sheets will be made only on the basis of specific requests therefor. With each bound copy and loose-leaf set, a post card is included to facilitate requesting correction sheets or replacement sheets, as the case may be. If the post card is not used, a request for correction material should be addressed to the Office of Weights and Measures, National Bureau of Standards, Washington 25, D. C., specifying the number of sets of correction sheets or replacement sheets required.

FUNDAMENTAL CONSIDERATIONS ASSOCIATED WITH THE ENFORCEMENT OF SPECIFICATIONS, TOLERANCES AND REGULATIONS

1. UNIFORMITY OF REQUIREMENTS

1.1. NATIONAL CONFERENCE CODES.—Weights and measures jurisdictions are urged to promulgate and adhere to the National Conference codes, to the end that uniform requirements may be in force throughout the country. This action is recommended even though a particular jurisdiction does not wholly agree with every detail of the National Conference codes. Uniformity of specifications and tolerances is an important factor in the manufacture of commercial equipment. Deviations from standard designs, to meet the special demands of individual weights and measures jurisdictions, are expensive, and any increase in costs of manufacture is, of course, passed on to the purchaser of equipment. On the other hand, if designs can be standardized by the manufacturer to conform to a single set of technical requirements, production costs can be kept down, to the ultimate advantage of the general public. Moreover, it seems entirely logical that equipment that is suitable for commercial use in the "specification" States should be equally suitable for such use in other States.

Another consideration supporting the recommendation for uniformity of requirements among weights and measures jurisdictions is the cumulative and regenerative effect of the widespread enforcement of a single standard of design and performance. The enforcement effort in each jurisdiction can then reinforce and support the enforcement effort in all other jurisdictions. More effective regulatory control can be brought about, and this result can actually be realized with less individual effort, under a system of uniform requirements, than under a system in which even minor deviations from standard practice are introduced by independent State action.

Since the National Conference codes represent the majority opinion of a large and representative group of experienced regulatory officials, and since these codes are recognized by equipment manufacturers as their basic guide in the design and construction of commercial weighing and measuring equipment, the acceptance and promulgation of these codes by each State is strongly recommended.

1.2. FORM OF PROMULGATION.—A convenient and very effective form of promulgation already successfully used in a considerable number of States is promulgation by citation of National Bureau of Standards Handbook 44. It is especially helpful when the citation is so made that, as amendments are adopted from time to time by the National Conference on Weights and Measures, these automatically go into effect in the State in question without the need for further promulgation by the State regulatory authority. For example, the following form of promulgation has been used successfully, and is recommended for consideration:

> The specifications, tolerances, and regulations for commercial weighing and measuring devices, together with amendments thereto, as adopted by the National Conference on Weights and Measures, recommended by the National Bureau of Standards, and published in National Bureau of Standards Handbook 44 and supplements, thereto, or in any publication revising or superseding Handbook 44, shall be the specifications, tolerances, and regulations for commercial weighing and measuring devices in the State of [insert name of State].

In some States it is preferred to base technical requirements upon specific action of the State legislature, rather than upon an act of promulgation by a State officer. The advantages cited above may be obtained and may yet be surrounded by adequate safeguards to insure proper freedom of action by the State enforcing officer, if the legislature adopts the National Conference requirements by language somewhat as follows:

> The specifications, tolerances, and regulations for commercial weighing and measuring devices, as recommended by the National Bureau of Standards, shall be the specifications, tolerances, and regulations for commercial weighing and measuring devices of the State of [insert name of State], except insofar as specifically modified by a regulation issued by the State [insert title of enforcing officer].

2. TOLERANCES FOR COMMERCIAL EQUIPMENT

2.1. ACCEPTANCE AND MAINTENANCE TOLERANCES.—The official tolerances prescribed by a weights and measures jurisdiction for commercial equipment are the limits of inaccuracy officially permissible within that jurisdiction. It is recognized that errorless value or performance of mechanical equipment is unattainable. Tolerances are established, therefore, to fix the range of inaccuracy within which equipment will be officially approved for commercial use. In the case of classes of equipment on which the magnitude of the errors of value or performance may be expected to change as a result of use, two sets of tolerances are established, "acceptance" tolerances and "maintenance" tolerances. Acceptance tolerances are applied to new or newly reconditioned or adjusted equipment and are smaller than (usually one-half of) the maintenance tolerances. Maintenance tolerances thus provide an additional range of inaccuracy within which equipment will be approved on subsequent tests, permitting a limited amount of "deterioration" before the equipment will be officially rejected for inaccuracy, and before reconditioning or adjustment will be required. In effect, there is assured a reasonable period of use for equipment after it is placed in service before reconditioning will be officially required. The foregoing comments do not apply, of course, when only a single set of tolerance values is established, as is the case with such equipment as, for example, glass milk bottles and graduates, which maintain their original accuracy regardless of use, and measure-containers, which are used only once.

When tables of tolerances for general weights and measures use are published, if the acceptance and maintenance tolerances differ, it is customary to use the maintenance tolerances for the tabular values, stating the values of the acceptance tolerances in terms of the maintenance tolerances. This is done for convenience of reference by the official, since it is to be expected that he will actually make many more maintenance tests than acceptance tests and so will have more frequent need to use maintenance tolerances than he will to use acceptance tolerances. If maintenance and acceptance tolerances are the same, or if only acceptance tolerances are applicable, the tables are appropriately headed to indicate these facts.

2.2. THEORY OF TOLERANCES.—The theory of tolerances is that their values are so fixed that, on the one hand, permissible errors are kept so small that neither party to a commercial transaction involving the equipment in question will be seriously injured, and that, on the other hand, such a high order of accuracy is not required as to make manufacturing or maintenance costs disproportionately high. Quite obviously, the equipment manufacturer must know what tolerances his product will be required to meet, so that he can manufacture economically. The commercial product must be required to be good enough to satisfy commercial needs, but it should not be required to be made unreasonably costly, complicated, or delicate in order to insure a reduction of its errors to unnecessarily small values. It may well be repeated that manufacturing is simplified and that the level of equipment prices is lowered in proportion to the degree of uniformity among weights and measures jurisdictions in their tolerance requirements and in their specifications for commercial devices.

2.3. TOLERANCES AND ADJUSTMENTS.—There is another aspect of tolerances that merits careful thought; this is the extent to which tolerances should be considered by those persons engaged in the actual adjustment for accuracy of commercial equipment. The ideal situation would be for equipment to be without error. Since it is not practical to require errorless value or performance, a reasonable approximation of this is fixed for enforcement purposes. But, when equipment is being adjusted for accruacy, either initially or following repair or official rejection, the effort should be to adjust as closely as practicable to zero error. Tolerances are primarily accuracy criteria *for use by the regulatory official.* Equipment owners should never be permitted to take advantage of tolerances by deliberately adjusting their equipment to have a value or to give performance at or close to the tolerance limit. Nor should the repair or service man be permitted to bring equipment merely within tolerance range when, by the exercise of reasonable skill and with the expenditure of a reasonable amount of time and effort, adjustment closer to zero error can be accomplished.[3]

[3] See General Regulation G–R. 4.

3. TESTING APPARATUS

3.1. ADEQUACY.—It is axiomatic that tests can be made properly only if, among other things, *adequate* testing apparatus is available. Testing apparatus may be considered adequate only when it is properly designed for its intended use, when it is so constructed that it will retain its characteristics for a reasonable period under conditions of normal use, when it is available in denominations appropriate for a proper determination of the value or performance of the commercial equipment under test, and when it is accurately calibrated.

3.2. TOLERANCES FOR STANDARDS.[4]—A general principle that has long been recognized by the National Bureau of Standards is that the error on a standard used by a weights and measures official should either be known and corrected for when the standard is used or, if the standard is to be used "without correction", its error should be not greater than 25 percent of the smallest tolerance to be applied when the standard is used. The reason for this is to keep at a minimum the proportion of the tolerance on the item being tested that will be "used up" by the error of the standard. Expressed differently, the reason is to give the item being tested as nearly as practicable the full benefit of its own tolerance.

Field testing operations are complicated to some degree when corrections to standards are applied, and except for work of relatively high precision it is recommended that the accuracy of standards used in testing commercial weighing and measuring equipment be so established and maintained that the use of corrections is not necessary. Also, whenever it can readily be done, it will be desirable to reduce the error on a standard below the 25-percent point previously mentioned.

3.3. ACCURACY OF STANDARDS.—The accuracy of testing apparatus should invariably be verified prior to the official use of the apparatus. Standards should be reverified as often as circumstances require. By their nature, metal

[4] The numerical values of the tolerances observed by the National Bureau of Standards for the standards of length, mass, and capacity used by weights and measures officials may be obtained upon request made to the Office of Weights and Measures of the Bureau.

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volumetric standards are more susceptible to damage in handling than are standards of some other types. Whenever damage to a standard is known or suspected to have occurred, and whenever repairs that might affect the accuracy of a standard have been made, the standard should be recalibrated. Routine recalibration of standards, particularly volumetric standards, even when a change of value is not anticipated, should be made with sufficient frequency to establish the fact of their continued accuracy, so that the official may always be in an unassailable position with respect to the accuracy of his testing apparatus. If use is made of "secondary" standards, such as special fabric testing tapes or mechanisms such as fluid meters, these should be verified much more frequently than such basic standards as steel tapes or volumetric provers, to demonstrate their constancy of value or performance.

It may be appropriate to mention here the lack of attention to the accuracy of their standards shown by some repair and service men and by some weights and measures officials, and the inadequate amount of testing apparatus with which service men and officials are sometimes provided. Accurate and dependable results can not be obtained with faulty or inadequate standards, and if either service man or official is poorly equipped it can not be expected that their results will check consistently. Disagreements between service men and officials can be avoided, and the servicing of commercial equipment can be expedited and improved, if service men and officials will give equal attention to the adequacy and maintenance of their testing apparatus.

4. INSPECTION OF COMMERCIAL EQUIPMENT

4.1. INSPECTION VERSUS TESTING.—A distinction may be made between the "inspection" and the "testing" of commercial equipment, which should be useful in differentiating between the two principal groups of official requirements—"specifications" and "performance requirements". Although frequently the term "inspection" is loosely used to include everything that the official has to do in connection with commercial equipment, it is useful to limit the scope of that term primarily to examinations made to determine compliance with the requirements of specifications. The term "testing" may then be limited to those operations

carried out to determine the accuracy of value or performance of the equipment under examination, by comparison with the actual physical standards of the official. These two terms will be used herein in the limited senses defined.[5]

4.2. NECESSITY FOR INSPECTION.—It is not enough merely to determine that the errors of equipment do not exceed the appropriate tolerances. Specification requirements may be equally as important as are tolerance requirements, and both should be enforced. Inspection is particularly important, and should be carried out with unusual thoroughness, whenever the official examines a type of equipment not previously encountered. This is the way the official learns whether or not the design and construction of the device conform to the specification requirements. But even a device of a type with which the official is thoroughly familiar and that he has previously found to meet specification requirements should not be accepted entirely "on faith". Some part may have become damaged, or some detail of design may have been changed by the manufacturer, or the owner or operator may have removed an essential element or made an objectionable addition. Such conditions may be learned only by inspection. Some degree of inspection is, therefore, an essential part of the official examination of every piece of weighing or measuring equipment.

4.3. SPECIFICATION REQUIREMENTS.—A thorough knowledge by the official of the specification requirements is a prerequisite to competent inspection of equipment. The inexperienced official should have his specifications before him when making an inspection, and should check the requirements one by one against the equipment itself; otherwise some important requirement may be overlooked. As experience is gained, the official will become progressively less dependent on "the book", until finally observance of faulty conditions becomes almost automatic, and the time and effort required to do the inspecting are reduced to a minimum. The printed specifications, however, should always be available for reference, to refresh the official's memory or to be displayed to support his decisions, and they are an essential item of his kit.

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[5] The testing of commercial equipment is treated in detail in National Bureau of Standards Handbook 37, Testing of Weighing Equipment, and National Bureau of Standards Handbook 45, Testing of Measuring Equipment.

It will not be inappropriate to remind officials and others who are using the National Conference codes that the specification requirements for a particular class of equipment are not all to be found in the separate code for that class. The requirements of the General Code apply, in general, to *all* classes of equipment, and these must always be considered in combination with the requirements of the appropriate separate code to arrive at the total of the requirements applicable to a piece of commercial equipment. There should also be emphasized the importance of keeping the book of specifications, tolerances, and regulations fully up to date by posting therein all changes that are adopted from time to time.

4.4. GENERAL CONSIDERATIONS.—The simpler the commercial device, the fewer, generally speaking, are the specification requirements affecting it and the easier and quicker can an adequate inspection be made. As a device increases in complexity, inspection demands more and more time and effort; moreover, inspection becomes increasingly important as mechanical complexity increases, because the opportunities for the existence of faulty conditions are multiplied. It is on the relatively complex device, too, that the unscrupulous operator is most apt to attempt some modification to gain an advantage to which he is not lawfully entitled. Of course, not every modification made by an operator is made with dishonest intentions. But sometimes a change made innocently enough has most unfortunate results, because the operator does not thoroughly understand his equipment and so fails to appreciate the effects of what seems to him to be a simple and desirable modification. So it behooves the official to be alert to discover all of the "homemade" alterations that may be made to commercial equipment, in order that he may cause the elimination of all that are fraudulent, all that facilitate or are conducive to the perpetration of fraud, and all that are otherwise objectionable from a weights and measures viewpoint.

It is essential for the official to know how a particular commercial device is normally designed and constructed, in order to discover, upon inspection, deviations from standard practice. Such knowledge can be obtained from the catalogs and advertising literature of manufacturing plants, from observation of the operations performed by service men when reconditioning equipment in the field, and from study of the commercial devices themselves. Furthermore, to determine the

effect of some deviation from accepted design, the official must know the operating principles of the device in question and be able to deduce or demonstrate how these are or may be violated by the alteration of the original mechanism. Much helpful information on the design and operating characteristics of commercial equipment can be obtained from the trained service mechanics and from the engineers of the equipment manufacturers; it is recommended that officials take advantage of every opportunity to "talk shop" with such men and so add to their knowledge of the construction and operation of weighing and measuring equipment of different kinds and makes.

Inspection should be extended beyond the instrument itself to include any auxiliary equipment the performance of which has a bearing on the performance characteristics of the instrument under examination, or has any weights and measures significance in relation to the operation of the instrument under examination. General conditions external to the equipment should likewise be observed, to learn any adverse effects that they may have, from the weights and measures point of view, upon the installation as a whole.

It is important not only that the required elements of a commercial instrument be provided, but also that these be in proper condition to function as intended. Inspection will frequently disclose the need for maintenance work before deterioration has progressed to the point of failure or before official rejection of the equipment becomes necessary. Mechanical parts may be worn or weakened. Leaks may be developing in volumetric equipment. Certain elements may be in need of cleaning or refinishing. Evidence may be found of poor general maintenance that is shortening the useful life of the equipment.

4.5. MISUSE OF EQUIPMENT.—Inspection, coupled with judicious inquiry, will sometimes disclose that equipment is being improperly used, either through ignorance of the proper method of operation or because some other method is preferred by the operator. Equipment should be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment, and operation in any other manner should be prohibited.

4.6. RECOMMENDATIONS.—A comprehensive knowledge of each installation will enable the official to make constructive recommendations to the equipment owner regarding proper maintenance of his weighing and measuring devices and the suitability of his equipment for the purposes for which it is being used or for which it is proposed that it be used. Such recommendations are always in order and may be very helpful to an owner. The official will, of course, carefully avoid partiality toward or against equipment of specific makes, and will confine his recommendations to points upon which he is qualified, by knowledge and experience, to make suggestions of practical merit.

Inspection will often provide clues to the causes of faulty performance of equipment, thus enabling the official to make specific suggestions for the reconditioning of rejected devices. Such suggestions, based upon a careful diagnosis, can be of material assistance to an equipment owner, and may effect a saving of time and money. The official is cautioned, however, that suggestions of this kind are, in a strict sense, "extra-official"; legally he need go no further, in the case of equipment that he cannot approve for commercial use, than to reject it, leaving it to the owner to take whatever steps he sees fit to accomplish the reconditioning of his equipment. Although it is recommended that officials make helpful suggestions of the kind here under discussion when they are fully qualified to do so, in a spirit of rendering maximum service to the public, the inexperienced official will do well to refrain from this course lest he render a wrong diagnosis or suggest a wrong procedure.

4.7. ACCURATE AND CORRECT EQUIPMENT.—Finally, the weights and measures official is reminded that commercial equipment may be "accurate" without being "correct". A device is "accurate", under the definition in the General Code of the National Conference (G. D. 11.) "when its performance or value—that is, its indications, its capacity, its deliveries, its registrations, its actual value, etc., as determined by tests made with suitable standards—conforms to the standard within the applicable tolerances and other performance requirements." Equipment that fails so to conform is "inaccurate". A device is "correct" (G. D. 12.) only when "in addition to being accurate, it meets all applicable specification requirements"; and if it fails to meet any of the requirements for correct equipment it is "incorrect". Only equipment that is "correct" should be sealed and approved for commercial use.

5. CORRECTION OF COMMERCIAL EQUIPMENT

5.1. ADJUSTABLE ELEMENTS.—Many types of weighing and measuring instruments are not susceptible of adjustment for accuracy by means of adjustable elements. Linear measures, liquid measures, graduates, measure-containers, milk and lubricating-oil bottles, farm milk tanks, dry measures, and some of the more simple types of scales are in this category. Other types—for example, taximeters and odometers and some metering devices—may be adjusted in the field, but only by changing certain parts such as gears in gear trains. Some types, of which fabric-measuring devices and cordage-measuring devices are examples, are not intended to be adjusted in the field, and, if inaccurate, require reconditioning in shop or factory. Liquid-measuring devices and most scales are equipped with adjustable elements, and some vehicle-tank compartments have adjustable indicators; field adjustments may readily be made on such equipment. In the discussion that follows, the principles pointed out and the recommendations made are applicable to adjustments on any commercial equipment, by whatever means accomplished.

5.2. WHEN CORRECTIONS SHOULD BE MADE.—The weights and measures official should remember that when he examines commercial equipment his *duty* is merely to determine that the equipment is or is not suitable for commercial use, and to approve or reject it accordingly. As the criteria for this determination, he has his specifications and tolerances. If a device conforms to all of the official requirements, it is approved for use and is "sealed" to indicate this approval. If a device is incorrect, in that it fails to meet one or more of the applicable requirements, basically the official is *required* only to reject it and prohibit its use until it is brought into conformance with all applicable requirements. The point of importance to this discussion is that the official is *not required* to undertake adjustments or other corrections on equipment found to be faulty.

Whether or not the official *should* at times make adjustments or other corrections on equipment found to be incorrect is a moot question. Some officials contend that this should never be done, and that an official should confine himself strictly to those duties imposed upon him by his statute.

Other officials—and these are believed to be a majority—take a more liberal view, and hold that under some circumstances a weights and measures officer is serving the best interests of all concerned by making such minor corrections and such adjustments (when adjustment is called for) as may be required to correct equipment found to be faulty and thus to keep it in commercial service. Within proper limitations, this latter view seems to be the more sound, but the limitations are of importance.

It is recommended that the official never undertake repairs of a major character. Such repairs should always be left to commercial agencies.

It is recommended that the official refrain from making even minor corrections when the services of commerical agencies are readily available. The justification for the undertaking, by the official, of minor corrections lies in the delay and the expense that would be incurred if these corrections were required to be made by a service agency and the nearest service agency were located at a considerable distance. The saving to the equipment owner is a consideration, as is also the saving in time and expense on the part of the official, who may thus avoid a return visit for a retest. Another consideration is that the equipment may be kept in service without interruption; this is of particular importance if the owner happens to be dependent upon only a single item of equipment and would be "out of business" while this was tied up for repairs.

The official is cautioned about turning too quickly to the adjustable elements of a commerical device to correct for inaccuracies. Many times the cause of inaccurate performance of such an instrument as, for example, a liquid meter or a scale, lies not in a faulty positioning of the adjustable elements, but in some fault of installation or some defective part. Any faulty installation conditions should be corrected, and any defective parts should be renewed or suitably repaired, before adjustments are undertaken. In other words, adjustment should be made only when it is certain that by this means the real cause of the inaccuracy will be corrected.

Under no circumstances should the official undertake an adjustment or other correction on commercial equipment unless he thoroughly understands what he is doing and is competent to complete successfully what he undertakes.

He should not experiment with equipment belonging to a commercial user, with the possibility of leaving it in worse shape than that in which he found it. Even when he is fully competent to make minor corrections and adjustments, the official should undertake them only with the express permission of the owner or his representative and with the definite understanding that there is no guarantee of a successful outcome; in this way the official will protect himself from adverse criticism and from possible claims for damage to equipment.

5.3. CHARGES FOR CORRECTIONS.—The practical and ethical objections to charges made by an official for services such as are here under discussion are so well understood that it should be unnecessary to elaborate upon them. In the absence of statutory authorization or direction, the official should never charge an equipment owner for these services, which he is justified in undertaking, if at all, only in the public interest. In those rare instances in which the law specifically authorizes or directs the assessment against an equipment owner of charges for repairs or corrections made by a weights and measures official, it is believed that the law should promptly be changed to delete such authorization or directive.

5.4. GAGING.—In the majority of cases, when the weights and measures official tests commercial equipment, he is verifying the accuracy of a value or the accuracy of the performance as previously established, either by himself or by some one else. There are times, however, when the test of the official is the initial test on the basis of which the value of the device is first fixed or its performance first established. The most common example of such "gaging" is in connection with vehicle tanks the compartments of which are used as measures; not infrequently the official makes the first determination to be made on the capacities of the compartments of a vehicle tank, and his test results are used to determine the proper settings of the compartment indicators for the exact compartment capacities desired. Adjustments of the position of an indicator under these circumstances are clearly not the kind of "adjustments" under discussion above.

6. REJECTION OF COMMERCIAL EQUIPMENT

6.1. CONDEMNATION FOR REPAIR AND CONDEMNATION.—The weights and measures law usually contains a provision to the general effect that the official "shall reject and mark or tag as 'condemned for repair' such weights and measures as he finds, upon inspection or test, to be incorrect * * * but which in his best judgment are susceptible of satisfactory repair; but he shall condemn, and may seize and destroy, weights and measures found to be incorrect which in his best judgment are not susceptible of satisfactory repair."[6] This provision is customarily followed by others requiring that equipment that has been "condemned for repairs" be corrected within such reasonable period as may be specified by the official, that if not so repaired the equipment shall be confiscated, and that pending repairs the equipment shall be neither used not disposed of in any way but shall be held at the disposal of the official.

These broad powers should be used by the official with discretion. He should keep always in mind the property rights of an equipment owner, and cooperate in working out arrangements whereby an owner can realize at least something from equipment that has been condemned, In cases of doubt, the official should initially "condemn for repairs" rather than condemn outright. Destruction of equipment is a harsh procedure, as is also confiscation; power to seize and destroy is necessary for adequate control of extreme situations, but seizure and destruction should be resorted to only when clearly justified.

On the other hand, condemnation for repair is clearly inappropriate for numerous items of measuring equipment. This is true in the case of most linear measures, of many liquid and dry measures, and graduates, measure-containers, milk bottles, lubricating-oil bottles, and some scales. When such equipment is incorrect it is either impractical or impossible to adjust or repair it, and the official has no alternative to outright condemnation. When only a few such items are involved, immediate destruction or confiscation is probably the best procedure. If a considerable number of items are involved—as, for example, a stock of measures in the hands

[6] Quoted from the Model State Law on Weights and Measures as adopted by the National Conference on Weights and Measures.

of a dealer, or a large shipment of bottles—return of these to the manufacturer for credit or replacement should ordinarily be permitted so long as the official is assured that they will not get into commercial use. Thus the official can protect the owner financially and can make possible the conservation of at least some of the material of which the equipment is constructed. In rare instances confiscation and destruction are justified as a method of control where less harsh methods have failed.

In the case of incorrect mechanisms such as fabric-measuring devices, taximeters, liquid-measuring devices, and most scales, repair of the equipment is usually possible, so condemnation for repair is the customary procedure. Seizure may occasionally be justified, but in the large majority of instances this should be unnecessary. Even in the case of worn-out equipment, some salvage is usually possible, and this should be permitted under proper controls.

7. TAGGING OF EQUIPMENT

7.1. "CONDEMNED FOR REPAIRS" AND "CONDEMNED".—It will ordinarily be practicable to mark or tag as "condemned for repairs" each item of equipment found to be incorrect and considered susceptible of proper reconditioning, and this should always be done unless the repairs are to be begun immediately. However, the tagging of equipment as "condemned" to indicate that it is permanently out of service, is not to be recommended if there is any other way in which the equipment can definitely be put out of service. When it is decided that equipment cannot successfully be repaired, dismantling, removal from the premises, or confiscation by the official are preferable to mere marking.

7.2. "NONSEALED" AND "NONCOMMERCIAL."—It sometimes happens that measuring equipment cannot be tested by the official at the time of his regular visit to the premises where the equipment is located. This situation can arise, for example, when there is no gasoline in the supply tank of a gasoline-dispensing device, or when the supply of lubricant for a lubricant-measuring device is exhausted. In such circumstances, condemnation for repair is not appropriate. Some officials affix to such equipment a "nonsealed"

tag, stating that the device has not been tested and sealed and that it must not be used commercially until it has been officially tested and approved. This form of marking is recommended whenever, in a case of this kind, any considerable time will necessarily elapse before the device can be tested.

A somewhat similar situation is occasionally met in an establishment with commercial equipment in use but having also on hand some equipment that is not in service, that may never be put into service, but that is of a type suitable for commercial use and that might be so used at some future time. Such equipment (1) may be tested and otherwise treated by the official just as he treats equipment in commercial service, (2) if readily portable it may be removed from the premises to eliminate possibility of its inadvertent use for commercial purposes, or (3) it may be marked "nonsealed".

Finally, there are instances of noncommercial equipment and commercial equipment installed or used in close proximity. In such a case, if there is a reasonable probability that the noncommercial equipment might be used for commercial purposes, (1) this should be treated by the official as commercial equipment, (2) a physical separation of the two groups of equipment should be effected so that misuse of the noncommercial equipment will be effectively prevented, or (3) the noncommercial equipment should be tagged to show that it is in noncommercial service, has not been officially tested, and is not to be used commercially.

8. RECORDS OF EQUIPMENT

8.1. The official will be well advised to keep careful records of equipment that is condemned for repairs so that he may follow up on this to insure that the repairs have been made as prescribed. As soon as practicable following completion of the repairs, the equipment should be retested. Complete records should also be kept of equipment that has been tagged as "nonsealed" or "noncommercial"; such records may be invaluable should it subsequently become necessary to take disciplinary steps because of the improper use of such equipment.

9. SEALING OF EQUIPMENT

9.1. TYPES OF SEALS AND THEIR LOCATION.—All equipment that is officially approved for commercial use (with certain exceptions to be pointed out later) should be suitably marked, or "sealed," to show this fact. Because it is desirable that the public be advised that the equipment that is used to serve them has been officially examined and approved, the seal of approval should, within reasonable limits, be as conspicuous as circumstances permit and should be of such a character and so applied that it will be reasonably permanent. The seal should be so positioned on a piece of equipment that it will be conspicuous, particularly to the public. Uniformity of position of the seal on similar types of equipment is also desirable, and this is an aid to the public in determining quickly that a piece of equipment has been tested and found correct.

It will be necessary for the official to have more than one form of seal to meet the requirements of different kinds of equipment. For instruments such as fabric-measuring devices, liquid-measuring devices, taximeters, and most scales, good quality, weather resistant, water-adhesive or pressure-sensitive seals or decalcomania seals are recommended; these may be somewhat more expensive than other types, but their qualities of permanence and good appearance recommend them highly. Steel stamps are most suitable for liquid and dry measures, for some types of linear measures, and for weights. An etched seal, applied with suitable etching ink, is excellent for steel tapes and greatly preferable to a seal applied with a steel stamp. The only practicable seal for a graduate is one marked with a diamond or carbide pencil or one etched with glass-marking ink. For a vehicle tank the official may wish to devise a relatively large seal, perhaps of metal, with provision for stamping data relative to compartment capacities, the whole to be welded or otherwise permanently attached to the shell of the tank. In general, the lead-and-wire seal is not suitable as an approval seal.

9.2. EXCEPTIONS.—An exception is made to the general rule that all equipment approved for commercial use should be individually sealed to show this approval, with respect to such equipment as is not individually tested but is approved upon the basis of tests of samples only. In this

category are measure-containers, milk bottles, and lubricating-oil bottles. The official normally tests samples of these items preliminary to their sale within his jurisdiction, and subsequently makes "spot checks" by testing representative samples of the measure-containers or bottles selected at random from new stocks. The theory upon which this procedure is justified is that manufacturing processes for these items can be and are closely controlled and that an essentially uniform product is produced by each manufacturer. Thus, if a particular item is once found to be correct, the manufacturer can duplicate that in his regular production; to see that he does so, the official tests samples of the product from time to time.

It would be physically possible to test and seal individually all glass bottles in use. To do this, however, would be a tremendous task, requiring the expenditure of a large amount of time and effort. Considering the high degree of uniformity of the bottles manufactured by modern processes, the slight increase in accuracy to be gained by the individual testing of bottles by weights and measures officials, as compared with the method of testing by sample, is clearly out of all proportion to the difference between the costs of the two methods. In the case of single-service measure-containers, individual testing is not possible, and supervision can only be exercised by the method of testing by sample.

A further exception to the general rule for sealing all approved equipment is found in certain very small weights whose size precludes satisfactory stamping with a steel die.

10. ROUNDING OFF

10.1. DEFINITION.—To "round off" or "round" a numerical value is to reduce its indicated accuracy to some predetermined point considered desirable or adequate for the purpose at hand, by dropping or raising certain figures. For example, if a computed, observed, or accumulated value is 4,738,221, this can be rounded off to the nearest million, to the nearest hundred thousand, to the nearest ten thousand, etc., as desired. Such rounded off values would be, respectively, 5,000,000, 4,700,000, 4,740,000, etc. Similarly, a value such as 47.382 can be rounded off to two decimal places, to one decimal place, to the units place, etc.; the rounded off figures in this example would be, respectively, 47.38, 47.4, 47, etc.

10.2. GENERAL RULES.—The general rules for rounding off may be stated briefly as follows:

(a) When the figure next beyond the last figure or place to be retained is less than 5, the figure in the last place retained is to be kept unchanged. (When rounding off 4,738,221 to the nearest hundred thousand, it is noted that the figure 3—next beyond the last figure to be retained—is less than 5, thus the rounded off value would be 4,700,000. Likewise, 47.382 rounded to two decimal places becomes 47.38.)

(b) When the figure next beyond the last figure or place to be retained is greater than 5, the figure in the last place retained is to be increased by 1. (When rounding off 4,738,221 to the nearest million, it is noted that the figure 7—next beyond the last figure to be retained—is greater than 5, thus the rounded off value would be 5,000,000. Likewise, 47.382 rounded to one decimal place becomes 47.4.)

(c) When the figure next beyond the last figure to be retained is 5 followed by any figures other than zero(s), treat as in (b), above, that is, the figure in the last place retained is to be increased by 1. (When rounding off 4,500,001 to the nearest million, 1 is added to the millions figure and the result becomes 5,000,000.)

(d) When the figure next beyond the last figure to be retained is 5 and there are no figures, or only zeros, beyond this 5, the figure in the last place to be retained is to be left unchanged if it is "even" (0, 2, 4, 6, or 8) and is to be increased by 1 if it is "odd" (1, 3, 5, 7, or 9). (This is the "odd and even rule," and may be stated "if odd then add.") (Thus, rounding off to the first decimal place, 47.25 would become 47.2; 47.15 would become 47.2; 47.05 would become 47.0; and 47.95 would become 48.0; also, rounded to the nearest thousand, 4,500 would become 4,000; 2,500 would become 2,000; 9,500 would become 10,000; and 5,500 would become 6,000.)

It is important to remember that, when there are two or more figures to the right of the place where the last significant figure of the final result is to be, the entire series of such figures must be rounded off in one step and not in two or more successive rounding steps. Expressed differently, when two or more such figures are involved, these are not to

be rounded off individually, but are to be rounded off as a group. Thus, rounding off 47.3499 to the first decimal place, the result becomes 47.3. In arriving at this result, the figures "499" are treated as one unit, and, the 4 next beyond the last figure to be retained being less than 5, the "499" is dropped (see sub (a) above). It would be incorrect to round off these figures successively to the left so that 47.3499 would become 47.350 and then 47.35 and then 47.4.

10.3. APPLICATION TO READING OF INDICATIONS.—An important aspect of rounding off values is the application of these rules to the reading of indications of an indicator-and-graduated-scale combination (where the majority of the indications may be expected to lie somewhere between two graduations) if it is desired to read or record values only to the nearest graduation. Consider a vertical graduated scale and an indicator. Obviously, if the indicator is between two graduations but is closer to one graduation than it is to the other adjacent graduation, the value of the closer graduation is the one to be read or recorded. In the case where, as nearly as can be determined, the indicator is midway between two graduations, the odd-and-even rule is invoked, and the value to be read or recorded is that of the graduation whose value is "even." For example, if the indicator lies exactly midway between two graduations having values of 471 and 472, respectively, the indication should be read or recorded as 472, this being an "even" value; or, if midway between graduations having values of 474 and 475, the "even" value 474 should be read or recorded. Similarly, if the two graduations involved had values of 470 and 475, the "even" value of 470 should be read or recorded.

A special case not covered by the foregoing paragraph is that of a graduated scale in which successive graduations are numbered by two's, all graduations thus having "even" values, for example, 470, 472, 474, etc. When, in this case, an indication lies midway between two graduations, the recommended procedure is to depart from the practice of reading or recording only to the value of the nearest graduation, and to read or record the intermediate "odd" value.

10.4. APPLICATION OF RULES TO ROUNDING OFF OF COMMON FRACTIONS.—When applying the rounding-off rules to common fractions, the principles are to be applied to the numerators of the fractions that have, if necessary, been reduced to a common denominator. The principle of "5's"

is changed to the "one-half" principal, that is, add if more than one-half, drop if less than one-half, and apply the odd-and-even rule if exactly one-half. For example, a series of values might be $1\frac{1}{32}$, $1\frac{2}{32}$, $1\frac{3}{32}$, $1\frac{4}{32}$, $1\frac{5}{32}$, $1\frac{6}{32}$, $1\frac{7}{32}$, $1\frac{8}{32}$, $1\frac{9}{32}$, etc. Assume that these values are to be rounded off to the nearest eighth ($\frac{4}{32}$). Then,

$1\frac{1}{32}$ becomes 1 ($\frac{1}{32}$ is less than half of $\frac{4}{32}$, and accordingly is dropped).

$1\frac{2}{32}$ becomes 1 ($\frac{2}{32}$ is exactly one-half of $\frac{4}{32}$; it is dropped because it is rounded [down] to the "even" eighth, which in this instance is $\frac{0}{8}$).

$1\frac{3}{32}$ becomes $1\frac{4}{32}$ or $1\frac{1}{8}$ ($\frac{3}{32}$ is more than half of $\frac{4}{32}$, and accordingly is rounded [up] to $\frac{4}{32}$ or $\frac{1}{8}$).

$1\frac{4}{32}$ remains unchanged, being an exact eighth ($1\frac{1}{8}$).

$1\frac{5}{32}$ becomes $1\frac{4}{32}$ or $1\frac{1}{8}$ ($\frac{5}{32}$ is $\frac{1}{32}$ more than an exact $\frac{1}{8}$; $\frac{1}{32}$ is less than half of $\frac{4}{32}$ and accordingly is dropped).

$1\frac{6}{32}$ becomes $1\frac{8}{32}$ or $1\frac{1}{4}$ ($\frac{6}{32}$ is $\frac{2}{32}$ more than an exact $\frac{1}{8}$; $\frac{2}{32}$ is exactly one-half of $\frac{4}{32}$, and the final fraction is rounded [up] to the "even" eighth, which in this instance is $\frac{8}{8}$).

$1\frac{7}{32}$ becomes $1\frac{8}{32}$ or $1\frac{1}{4}$ ($\frac{7}{32}$ is $\frac{3}{32}$ more than an exact $\frac{1}{8}$; $\frac{3}{32}$ is more than one-half of $\frac{4}{32}$ and accordingly the final fraction is rounded [up] to $\frac{8}{8}$ or $\frac{1}{4}$).

$1\frac{8}{32}$ remains unchanged, being an exact eighth ($1\frac{8}{8}$ or $1\frac{1}{4}$).

$1\frac{9}{32}$ becomes $1\frac{8}{32}$ or $1\frac{1}{4}$ ($\frac{9}{32}$ is $\frac{1}{32}$ more than an exact $\frac{1}{8}$; $\frac{1}{32}$ is less than half of $\frac{4}{32}$ and accordingly is dropped).

and so forth.

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SPECIFICATIONS, TOLERANCES, AND REGULATIONS

GENERAL CODE

G–A. APPLICATION.

G–A.1. COMMERCIAL EQUIPMENT.—These specifications, tolerances, and regulations apply to commercial weighing and measuring equipment, that is, to weights and measures and weighing and measuring devices commercially used or employed in establishing the size, quantity, extent, area, or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure, or in determining weight or measure when a charge is made for such determination.

G–A.2. GENERAL CODE.—The requirements and provisions of the General Code apply to all classes or weighing and measuring equipment for which separate codes have been established, except insofar as they are specifically suspended, modified, or limited by the terms of the General Code or of some specific code.

G–A.3. SPECIFIC CODES.—The requirements and provisions of a specific code for a particular class or weighing or measuring equipment apply to all equipment falling clearly within such class, except insofar as they are specifically suspended, modified, or limited by the terms of the General Code or of the specific code itself.

G–A.4. SPECIAL AND UNCLASSIFIED EQUIPMENT.—Insofar as they are clearly appropriate, the requirements and provisions of the General Code and of specific codes apply to equipment failing, by reason of special design or otherwise, to fall clearly within one of the particular equipment classes for which separate codes have been established. With respect to such equipment, code requirements and provisions shall be applied with due regard to the design, intended purpose, and conditions of use of the equipment.

G–A.5. METRIC EQUIPMENT.—It is lawful throughout the United States to employ the weights and measures of the metric system, and these specifications, tolerances, and regulations shall not be understood or construed as in any way prohibiting the manufacture, sale, or use of equipment designed to give results in terms of metric units. The specific provisions of these requirements, and the principles upon which the requirements are based, shall be applied to metric equipment insofar as appropriate and practicable. The tolerances on metric equipment, when not specified herein, shall be equivalent to those specified for similar equipment constructed or graduated in the customary system.

G–D. DEFINITIONS.

G–D.1. SPECIFICATION.—A requirement usually dealing with the design, construction, marking, or installation of a weighing or measuring instrument, but at times dealing with performance requirements other than tolerances. Specifications are primarily directed to the manufacturers of devices.

G–D.2. TOLERANCE.—A value fixing the limit of allowable error or departure from true performance or value. (See also G–T.1., G–T.2., G–T.3., G–T.4., G–T.5., and G–T.6.)

G–D.3. NOTES.—A section included in each of a number of codes, wherein may be found testing instructions, and pertinent directives and information that cannot properly be classified as specifications. Notes are primarily directed to weights and measures officials.

G–D.4. REGULATION.—A requirement usually dealing with the selection or use of a weighing or measuring instrument, but at times dealing with installation requirements. Regulations are primarily directed to the users of devices.

G–D.5. RETROACTIVE.—"Retroactive" requirements are enforceable with respect to all equipment. Retroactive requirements are printed herein in ordinary roman type.

G–D.6. NONRETROACTIVE.—"Nonretroactive" requirements are enforceable only with respect to equipment that is manufactured in or brought into the State after the requirements have been promulgated. Nonretroactive requirements are not enforceable with respect to equipment that is in the State at the time of such promulgation, either in use or in the stocks of manufacturers of or dealers in such equipment. *Nonretroactive requirements are printed herein in italic type.*

G–D.7. TENTATIVE.—Requirements classed as "tentative" have only a trial or experimental standing and are not to be rigidly enforced. They represent requirements that have progressed beyond the initial development stage but upon which final action has not been taken, and that are being formally presented for observation and study to test the practicability and suitability of their final adoption.

G–D.8. NOMINAL.—Refers to "intended" or "named" or "stated", as opposed to "actual". For example, the "nominal value" of something is the value that it is supposed or intended to have, the value that it is claimed or stated to have, or the value by which it is commonly known or by which it is identified as belonging in a particular value category. Thus, "1-pound weight", "1-gallon measure", "1-yard indication", and "500-pound scale" are statements of nominal values; corresponding actual values may differ from these by greater or lesser amounts.

G–D.9. MULTIPLE.—An integral multiple, that is, a result obtained by multiplying by a whole number. ("Multiple of a scale" is defined in D. 3. of the scale code.)

G–D.10. BINARY SUBMULTIPLES.—Fractional parts obtained by successively dividing by the number 2. Thus, one-half, one-fourth, one-eighth, one-sixteenth, and so on, are binary submultiples.

G–D.11. ACCURATE.—A piece of equipment is "accurate" when its performance or value—that is, its indications, its capacity, its deliveries, its recorded representations, its actual value, etc., as determined by tests made with suitable standards—conforms to the standard within the applicable tolerances and other performance requirements. Equipment that fails so to conform is "inaccurate".

G–D.12. CORRECT.—A piece of equipment is "correct" when, in addition to being accurate, it meets all applicable specification requirements. Equipment that fails to meet any of the requirements for correct equipment is "incorrect".

G–D.13. SEAL.—A label, tag, stamped or etched impression, or the like, indicating official approval (approval seal), or means, such as a lead-and-wire seal, for protection against access, removal, or adjustment (security seal).

G–D.14. EXCESS AND DEFICIENCY.—When an instrument or device is of such a character that it has a value of its own that can be determined, its error is said to be "in excess" or "in deficiency" depending upon whether its actual value is, respectively, greater or less than its nominal value. This category of instruments includes such instruments as linear measures, liquid measures, milk bottles, vehicle-tank compartments, and weights. Examples of instruments having errors "in excess" are:

A linear measure that is too long.
A liquid measure that is too large.
A weight that is "heavy".

Examples of instruments having errors "in deficiency" are:

A lubricating-oil bottle that is too small.
A vehicle-tank compartment that is too small.
A weight that is "light".

G–D.15. OVERREGISTRATION AND UNDERREGISTRATION.—When an instrument or device is of such a character that it indicates or records values as a result of its operation, its error is said to be in the direction of overregistration or underregistration (that is, the device is "overregistering" or "underregistering"), depending upon whether the indications are, respectively, greater or less than they should be. This category of devices includes such devices as fabric-measuring devices, taximeters, liquid-measuring devices, and weighing scales. Examples of devices having errors of "overregistration" are:

A fabric-measuring device that indictes more than the true length of material passed through it.
A taximeter that indicates or records a fare corresponding to more than the actual distance traveled by the vehicle on which it is installed.
A liquid-measuring device that indicates more than the true amount of the liquid delivered by the device.

Examples of devices having errors of "underregistration" are:

A device for measuring lubricants that indicates less than the true amount of lubricant that it delivers.

A meter that indicates less than the true amount of product that it delivers.

A weighing scale that indicates or records less than the true value of the applied load.

G–D. 16. INDICATING ELEMENT.—An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is "read" from the device itself, as, for example, an index-and-graduated-scale combination, a weighbeam-and-poise combination, a straight-reading counter, and the like. The term includes an element, commonly referred to as a "registering" element, designed to retain its indications until reset or to accumulate totals.

G–D. 17. RECORDING ELEMENT.—An element incorporated in a weighing or measuring device by means of which its performance relative to quantity or money value is permanently recorded on a tape, ticket, card, or the like, in the form of a printed, stamped, punched, or perforated representation.

G–D. 18. PRIMARY INDICATING OR RECORDING ELEMENTS.—Those principal elements that are designed to be utilized by the operator in the normal commercial use of the weighing or measuring device in which they are incorporated. The term does not include such auxiliary elements as, for example, the totalizing register on a meter or the means for producing a running record of successive weighing operations, elements that are supplementary to those relating to individual deliveries or weights.

G–D. 19. SELECTOR-TYPE.—Refers to a system of indication or recording in which the mechanism selects, by means of a ratchet-and-pawl combination or by other means, one or the other of any two successive values that can be indicated or recorded.

G–D. 20. INDEX OF AN INDICATOR.—The particular portion of an indicator that is directly utilized in making a reading.

G–D. 21. GRADUATION.—A defining line, or one of the lines defining the subdivisions of a graduated series. The term includes such special forms as raised or indented or scored reference "lines" and special characters such as dots.

G–D. 22. MAIN GRADUATION.—One of those defining the primary or principal subdivisions of a graduated series.

G–D. 23. SUBORDINATE GRADUATION.—Any graduation other than a main graduation.

G–D. 24. GRADUATED INTERVAL.—The distance from the center of one graduation to the center of the next graduation of a graduated series.

G–D. 25. VALUE OF MINIMUM GRADUATED INTERVAL.—The smallest value represented by the interval from the center of one graduation to the center of the succeeding graduation. Also, the smallest increment of recorded value.

G–D. 26. CLEAR INTERVAL BETWEEN GRADUATIONS.—The interval between adjacent edges of successive graduations of a series of graduations. If the graduations are "staggered," the interval shall be measured, if necessary, between a graduation and an extension of the adjacent graduation.

G–D. 27. COMPUTING TYPE.—Refers to a device designed to indicate automatically the total money value of product weighed or measured, for one of a series of unit prices.

G–D. 28. COIN-OPERATED TYPE.—Refers to a device designed to be released for use by the insertion of a coin, or to be actuated by the insertion of a coin to make deliveries of product corresponding to specific money values at a definite unit price.

G–S. SPECIFICATIONS.

G–S.1. IDENTIFICATION.—*All commercial equipment except weights shall be conspicuously, clearly, and permanently marked, for purposes of identification, with the name, initials, or trademark of the manufacturer and with the manufacturer's designation that positively identifies the pattern or the design of the device.*

G–S.2. FACILITATION OF FRAUD.—All commercial equipment and all mechanisms and devices attached thereto or used in connection therewith shall be so constructed, assembled, and installed for use that they do not facilitate the perpetration of fraud.

G–S.3. PERMANENCE.—All commercial equipment shall be of such materials, design, and construction as to make it probable that, under normal service conditions, (a) accuracy will be maintained, (b) operating parts will continue to function as intended, (c) adjustments will remain reasonably permanent, (d) undue stresses will not be developed, and (e) undue deflections or distortion of parts will not occur.

G–S.4. DESIGN.—All weighing and measuring devices shall be provided with indicating or recording elements, appropriate in design and adequate in amount. Primary indications and recorded representations shall be clear, definite, accurate, and easily read under any conditions of normal operation of the device. *Graduations and a suitable indicator shall be provided in connection with indications and recorded representations designed to advance continuously.* Graduations shall not be required in connection with indications or recorded representations designed to advance intermittently or with indications or recorded representations of the selector type.

G–S.5. INDICATING ELEMENTS AND RECORDED REPRESENTATIONS.

G–S.5.1. GRADUATIONS.

G–S.5.1.1. GENERAL.—In any series of graduations, corresponding graduations shall be uniform in size and character. If graduations are intended to have specific values, these shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof, uniformly placed with reference to the graduations, and as close thereto as practicable, but not so positioned as to interfere with the accuracy of reading. Graduations and their defining figures, words, and symbols shall be of such character that they will not tend easily to become obliterated or illegible.

G–S.5.1.2. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

G–S.5.1.3. WIDTH.—In any series of graduations the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Except as provided in G–S.5.4., graduations shall in no case be less than 0.008 inch in width.

G–S.5.2. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.02 inch for graduations representing money values, not less than 0.03 inch for weighbeam graduations, and not less than 0.04 inch for other graduations, except as provided in G–S.5.4. If the graduations are not parallel, the measurement shall be made (1) along the line of relative movement between the graduations and the end of the indicator or (2) if the indicator is continuous, at the point of widest separation of the graduations.

G–S.5.3. INDICATORS.

G–S.5.3.1. GENERAL.—The index of an indicator shall be symmetrical about the graduations with which it is used. Parallax effects shall be reduced to the practicable minimum. Except as provided in G–S.5.4., the clearance between the index of an indicator and the graduations shall in no case be more than 0.06 inch.

G–S.5.3.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

G–S.5.3.3. WIDTH.—The width of the index of an indicator in relation to the series of graduations with which it is used shall be (a) not less than the width of the narrowest graduation, (b) not greater than the width of the widest graduation, (c) not greater than the width of the minimum clear interval between quantity graduations, and (d) not greater than three-fourths of the width of the minimum clear interval between money-value graduations.

G–S.5.4. REQUIREMENTS WHEN INDICATIONS ARE MAGNIFIED.—When in normal usage a series of graduations and an indicator on a weighing or measuring device are necessarily directly viewed as magnified by a lens system, the specified dimensions of 0.008 inch in G–S.5.1.3., 0.02 inch and 0.04 inch in G–S.5.2., and 0.06 inch in G–S.5.3.1., shall be reduced in inverse proportion to the effective angular magnification of the lens system in a vertical plane, determined when the eye of the observer is 12 inches from the graduations. When in normal usage a series of graduations is necessarily viewed as magnified and projected by an optical system onto a screen, the specified dimensions of 0.008 inch in G–S.5.1.3., and 0.02 inch and 0.04 inch in G–S.5.2., shall be applied to the magnified images as projected on the screen.

G–S.6. LETTERING.—All required markings and instructions shall be distinct and easily readable and shall be of such character that they will not tend easily to become obliterated or illegible.

G–N. NOTES.

G–N.1. CONFLICT OF LAWS AND REGULATIONS.—If any provisions of these specifications are found to conflict with existing State or local laws, ordinances, or regulations, relating to safety or fire prevention, the enforcement of such provisions shall be suspended until the conflicting requirements can be harmonized.

G–T. TOLERANCES.

G–T.1. ACCEPTANCE TOLERANCES.—Acceptance tolerances shall apply to equipment of the following classes:

(a) Equipment that is about to be put into use for the first time.

(b) Equipment that has been put into use within the preceding 3 months and is being officially tested for the first time.

(c) Equipment that is being officially tested for the first time within 3 months after major reconditioning or overhaul.

(d) Equipment that is being officially tested for the first time within 3 months after repair, adjustment, or other corrective service operation, following official rejection.

G–T.2. MAINTENANCE TOLERANCES.—Maintenance tolerances shall apply to equipment in actual use, except as provided in G–T.1.

G–T.3. APPLICATION.—Tolerances "in excess" and tolerances "in deficiency" shall apply to errors in excess and to errors in deficiency, respectively. (See G–D.14.) Tolerances "on overregistration" and tolerances "on underregistration" shall apply to errors in the direction of overregistration and of underregistration, respectively. (See G–D.15.)

G–T.4. FOR INTERMEDIATE VALUES.—For a capacity, indication, load, value, etc., intermediate between two capacities, indications, loads, values, etc., listed in a table of tolerances, the tolerance prescribed for the lower capacity, indication, load, value, etc., shall be applied.

G–T.5. FOR INDICATIONS AND RECORDED REPRESENTATIONS DESIGNED TO ADVANCE CONTINUOUSLY.—When a weighing or measuring device is equipped with indicating or recording elements designed to advance continuously, the regularly prescribed tolerances shall be applied to the indications and recorded representations.

G–T.6. FOR INDICATIONS AND RECORDED REPRESENTATIONS DESIGNED TO ADVANCE INTERMITTENTLY, OR OF SELECTOR TYPE.—When a weighing or measuring device is equipped with indicating or recording elements designed to advance intermittently or with indicating or recording elements of the selector type (see G–D.19.), the regularly prescribed tolerances shall be applied to the indications and recorded representations, except that there shall be added to the tolerances that would otherwise be applicable an amount equal to one-half the value of the increment between successive values that can be indicated or recorded.

G–R. REGULATIONS.

G–R.1. POSITION OF EQUIPMENT.—All equipment used in retail trade, except when used exclusively for putting up packages in advance of sale, shall be so positioned that its indications may be accurately read, and the weighing or measuring operation observed, from some reasonable "customer" position. The permissible distance between the equipment and a reasonable customer position shall be determined in each case upon the basis of the individual circumstances, particularly the size and character of the indicating elements.

G–R.2. MAINTENANCE OF EQUIPMENT.—All equipment in commercial service and all mechanisms and devices attached thereto or used in connection therewith shall continuously be maintained in proper operating condition throughout the period of such service.

G–R.3. SUITABILITY OF EQUIPMENT.—Commercial equipment shall be suitable as to design and capacity for the service in which it is used.

G–R.4. USE OF ADJUSTMENTS.—Weighing elements and measuring elements that are adjustable shall be adjusted only to correct those conditions that such elements are designed to control, and shall not be adjusted to compensate for defective or abnormal installation or accessories or for badly worn or otherwise defective parts of the assembly. Any faulty installation conditions shall be corrected, and any defective parts shall be renewed or suitably repaired, before adjustments are undertaken. Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.

G–R.5. METHOD OF OPERATION.—Equipment shall be operated only in the manner that is obviously indicated by its construction or that is indicated by instructions on the equipment.

SCALES

GENERAL CODE REFERENCES.—Each scale shall conform to all of the applicable requirements of the General Code. Each of the general specifications is applicable to one or more varieties of scales; accordingly, the entire General Code, including the general regulations, should be consulted.

A. APPLICATION

A.1. GENERAL.—The code for scales comprises general requirements that are generally applicable to all classes of weighing devices, and specific requirements for certain individual classes of such devices. Such specific requirements supersede general scale requirements in all cases of conflict. (See also G–A.1., G–A.2., G–A.3., G–A.4., and G–A.5.)

A.2. COMMERCIAL PERSON WEIGHERS.—The requirements for person weighers apply to coin-operated person weighers and to other scales used for weighing persons when a charge is made for the weighing service.

A.3. WHEEL-LOAD WEIGHERS, WHEEL-LOAD SCALES, AND AXLE-LOAD SCALES.—The requirements for wheel-load weighers, wheel-load scales, and axle-load scales apply to such scales in official use for the enforcement of traffic and highway laws, and should be applied to privately-owned scales of these types when these are being tested upon request.

D. DEFINITIONS

D.1. NOMINAL CAPACITY.—The largest weight indication that can be obtained by the use of all of the reading or recording elements in combination, including the amount represented by any removable weights furnished or ordinarily furnished with the scale, but excluding the amount represented by any extra removable weights not ordinarily furnished with the scale, and excluding also the capacity of any auxiliary weighing attachment not contemplated by the original design of the scale. However, when a scale is constructed to give weight indications in both the customary and metric systems, this definition shall be applied to the indications in one system only. Also, in applying this definition, the capacity of any fractional bar is to be included only when this exceeds 2½ percent of the sum of the capacities of the remaining reading elements.

D.2. READING-FACE CAPACITY.—The largest weight that may be indicated on the reading face, exclusive of the use of any unit weights or other elements.

D.3. MULTIPLE OF A SCALE.—In general, the multiplying power of the entire system of levers. Specifically, on a beam scale, the number of pounds on the load-receiving element that will be counterpoised by 1 pound applied to the tip pivot of the weighbeam.

D.4. SMALL-CAPACITY SCALE.—One of the bench (counter) or hanging type having a nominal capacity of 400 pounds or less.

D.5. LARGE-CAPACITY SCALE.—Any scale having a nominal capacity greater than 400 pounds, and also a scale of any capacity not of the bench (counter) or hanging type.

D.6. BEAM SCALE.—One on which the weights of loads of various magnitudes are indicated solely by means of one or more weighbeam bars either alone or in combination with counterpoise weights.

D.7. AUTOMATIC-INDICATING SCALE.—One on which the weights of applied loads of various magnitudes are automatically indicated throughout all or a portion of the weighing range of the scale. A "full-automatic-indicating" scale is one on which the capacity of the automatic-indicating elements equals the nominal capacity of the scale. A "semi-automatic-indicating" scale is one on which the capacity of the automatic-indicating elements is less than the nominal capacity of the scale. (A scale that automatically weighs out commodity in predetermined drafts, such as an automatic grain hopper scale, a packaging scale, and the like, is not an "automatic-indicating scale.)

D.8. EQUAL-ARM SCALE.—A small-capacity scale having only a single lever with equal arms (that is, with a multiple of 1), equipped with two similar or dissimilar load-receiving elements (pan, plate, "platter", scoop, or the like), one intended to receive material being weighed and the other intended to receive weights, these elements being maintained in position above the lever by means of a stabilizing linkage. There may or may not be a weighbeam ("side bar").

D.9. RECORDING SCALE.—One on which the weights of applied loads may be permanently recorded on a tape, ticket, card, or the like in the form of a printed, stamped, punched, or perforated representation.

D.10. SPRING SCALE.—An automatic-indicating scale in which the counterforce is supplied by an elastic body or system of such bodies, the shape or dimensions of which are changed by applied loads. A "compensated" spring scale is one equipped with a device intended to compensate for changes in the elasticity of the spring or springs resulting from changes in temperature, or one so constructed as to be substantially independent of such changes; an "uncompensated" spring scale is one not so equipped or constructed. A "straight-face" spring scale is one in which the indicator is affixed to the spring without intervening mechanism and that indicates weight values on a straight graduated reading face. (The use in a scale of metal bands or strips in lieu of pivots and bearings does not constitute the scale a "spring" scale.) [Effective July 1, 1957, this paragraph is rescinded.]

D.11. COMPUTING SCALE.—One that indicates the money values of amounts of commodity weighed, at predetermined unit prices, throughout all or part of the weighing range of the scale.

D.12. PREPACKAGING SCALE.—A computing scale specially designed for putting up packages of random weights in advance of sale.

D.13. PRESCRIPTION SCALE.—A scale or balance adapted to weighing the ingredients of medicinal and other formulas prescribed by physicians and others and used or intended to be used in the ordinary trade of pharmacists. "Class A" and "Class B" scales are those meeting the code requirements for prescription scales of Classes A and B, respectively.

D.14. JEWELERS SCALE.—One adapted to weighing gems and precious metals.

D.15 CREAM-TEST SCALE.—One adapted to determining the butterfat content of milk, cream, or butter.

D.16. MOISTURE-TEST SCALE.—One adapted to determining the moisture content of butter or cheese.

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D.17. PERSON WEIGHER.—A scale specially adapted to weighing persons. A "ticket" person weigher is one that, on each weighing operation, automatically records the weight on a ticket, card, or the like and automatically delivers this to a suitable receptacle on the outside of the scale.

D.18. WHEEL-LOAD WEIGHER.—A compact, self-contained, portable scale specially adapted to determining the wheel loads of vehicles on highways.

D.19. WHEEL-LOAD SCALE.—A scale, permanently installed in a fixed location, having a load-receiving element specially adapted to determining the wheel loads of highway vehicles.

D.20. AXLE-LOAD SCALE.—A scale, permanently installed in a fixed location, having a load-receiving element specially adapted to determining the combined load of all wheels (1) on a single axle or (2) on a tandem axle, of a highway vehicle.

D.21. VEHICLE SCALE.—One adapted to weighing highway vehicles, loaded or unloaded.

D.22. LIVESTOCK SCALE.—One having a nominal capacity of 6,000 pounds or more and used primarily for weighing livestock standing on the scale platform.

D.23. ANIMAL SCALE.—One adapted to weighing single heads of livestock.

D.24. COAL-MINE SCALE.—One used at a coal mining operation for determining the basic wages of miners on a production basis.

D.25. HAND-OPERATED GRAIN HOPPER SCALE.—One adapted to the manual weighing of variable loads of grain.

D.26. NOSE-IRON.—A slidably-mounted, manually-adjustable pivot assembly for changing the multiple of a lever.

D.27. WEIGHBEAM OR BEAM.—An element comprising one or more bars, equipped with movable poises or means for applying counterpoise weights or both.

D.28. MAIN BAR.—A principal weighbeam bar, usually of relatively large capacity as compared with other bars of the same weighbeam. (On an automatic-indicating scale equipped with a weighbeam, the main weighbeam bar is frequently called the "capacity" bar.)

D.29. TARE BAR.—An auxiliary weighbeam bar, primarily for the purpose of determining, or balancing out, the weights of empty containers or vehicles.

D.30. FRACTIONAL BAR.—A weighbeam bar of relatively small capacity, for obtaining indications intermediate between notches or graduations on a main or tare bar.

D.31. MAIN-WEIGHBEAM ELEMENTS.—The combination of a main bar and its fractional bar, or a main bar alone if this has no fractional bar associated with it.

D. 32. TARE-WEIGHBEAM ELEMENTS.—The combination of a tare bar and its fractional bar, or a tare bar alone if this has no fractional bar associated with it.

D. 33. POISE.—A movable weight mounted upon or suspended from a weighbeam bar and used in combination with graduations, and frequently with notches, on the bar to indicate weight values. (A suspended poise is commonly called a "hanging" poise.)

D. 34. READING FACE.—That element of an automatic-indicating scale on which weight values are automatically indicated. (A circular reading face is frequently called a "dial".)

D. 35. BALANCE INDICATOR.—A combination of elements, one or both of which will oscillate with respect to the other, for indicating the balance condition of a nonautomatic-indicating scale. The combination may consist of two indicating edges, lines, or points, or a single edge, line, or point and a graduated scale.

D. 36. OVER-AND-UNDER INDICATOR.—An automatic-indicating element incorporated in or attached to a scale and comprising an indicator and a graduated scale with a central or intermediate "zero" graduation and a limited range of weight graduations on either side of the zero graduation, for indicating weights greater than and less than the predetermined values for which other elements of the scale may be set. (A scale having an over-and-under indicator is classed as an automatic-indicating scale.)

D. 37. TELL-TALE ATTACHMENT.—An automatic-indicating element so connected to a beam scale that it operates with complete independence from the weighbeam. This attachment is not designed to be a weighing element. Its function is merely to shorten the time required for a weighing by quickly showing the weigher approximately where to position the weighbeam poises to establish proper weighbeam equilibrium.

D. 38. EQUAL-ARM WEIGHT.—One designed for use on a scale with a nominal multiple of 1.

D. 39. COUNTERPOSE WEIGHT.—A slotted or "hanger" weight intended for application near the tip of the weighbeam of a scale having a multiple greater than 1.

D.40. UNIT WEIGHT.—One contained within the housing of an automatic-indicating scale and mechanically applied to and removed from the mechanism.

D.41. COUNTERBALANCE WEIGHT.—One intended for application near the butt of a weighbeam for zero-load balancing purposes.

D.42. ZERO-LOAD BALANCE.—A correct weight indication or representation of zero when there is no load on the load-receiving element.

D.43. ZERO-LOAD BALANCE FOR A NONAUTOMATIC-INDICATING SCALE.—A condition in which (a) the weighbeam is at rest at or oscillates through approximately equal arcs above and below the center of a trig loop, (b) the weighbeam or lever system is at rest at or oscillates through approximately equal arcs above and below a horizontal position or a position midway between limiting stops, or (c) the indicator of a balance indicator is at rest at or oscillates through approximately equal arcs on either side of the zero graduation.

D.44. ZERO-LOAD BALANCE FOR AN AUTOMATIC-INDICATING SCALE.—A condition in which the indicator is at rest at or oscillates through approximately equal arcs on either side of the zero graduation.

D.45. ZERO-LOAD BALANCE FOR A RECORDING SCALE.—A condition in which the scale will record a representation of zero load.

D.46. RATIO TEST.—A test to determine the accuracy with which the actual multiple of a scale agrees with its designed multiple. This test is utilized in the case of scales employing counterpoise weights and is made with standard test weights substituted in all cases for the weights commercially used on the scale. (It is appropriate to utilize this test in the case of some scales not employing counterpoise weights.)

D.47. INCREASING-LOAD TEST.—The normal basic performance test for a scale, in which observations are made as increments of test-weight load are successively added to the load-receiving element of the scale.

D.48. DECREASING-LOAD TEST.—A special supplementary test for automatic-indicating scales only, intended to disclose the general condition of the scale with respect to accuracy of fits, lost motion in connections and gear trains, and general refinement of workmanship, as well as the weighing performance of the scale when loads are being reduced. In this test observations are made as decrements of test-weight load are successively removed from the load-receiving element of the scale.

D.49. SHIFT TEST.—A special, supplementary test intended to disclose the weighing performance of a scale under off-center loading and to assist in evaluating the accuracy of performance and correctness of adjustment of certain individual elements of the scale.

D.50. SENSIBILITY RECIPROCAL OR SR.—The change in load required to change the position of rest of the indicating element or elements of a nonautomatic-indicating scale a definite amount at any load.

D.51. SR FOR A SCALE WITH A TRIG LOOP BUT WITHOUT A BALANCE INDICATOR.—The change in load required to change the position of rest of the weighbeam from the center of the trig loop to the top or bottom of the trig loop, except as is provided in N. 1. 5.

D.52. SR FOR A SCALE WITHOUT A TRIG LOOP OR BALANCE INDICATOR.—The change in load required to change the position of rest of the weighbeam or lever system from the horizontal, or midway between limiting stops, to either limit of motion.

D.53. SR FOR A SCALE WITH A BALANCE INDICATOR.—The change in load required to cause (a) a relative change of 0.04 inch in the positions of rest of two indicators that move in opposite directions, (b) a change in the position of rest of an indicator such that there is a clear interval between adjacent edges of the indicator and a single zero graduation equal to 0.04 inch on a small-capacity scale, 0.12 inch on a large-capacity scale other than a vehicle, wheel-load, axle-load, livestock, coal-mine, or railway track scale, and 0.25 inch on a vehicle, wheel-load, axle-load, livestock, coal-mine, or railway track scale, or (c) a change in the position of rest of an indicator equal to one division on a graduated scale if this distance is greater than that specified in (b).

D.54. ACCEPTANCE SR REQUIREMENTS.—Acceptance SR requirements are applicable to scales to which acceptance tolerances are applicable. (See G–T.1.)

D.55. MAINTENANCE SR REQUIREMENTS.—Maintenance SR requirements are applicable to scales to which maintenance tolerances are applicable. (See G–T.1. and G–T.2.)

S. SPECIFICATIONS.

SPECIFICATIONS APPLICABLE TO ALL CLASSES OF SCALES

S.1. DESIGN.

S.1.1. STABILITY OF INDICATIONS.—A scale shall be capable of repeating, within prescribed tolerances, its indications and recorded representations. This requirement shall be met irrespective of repeated manipulation of any scale element in a manner duplicating normal usage, including (a) displacement of the indicating elements to the full extent allowed by the construction of the scale, (b) repeated operation of a locking or relieving device, (c) repeated application or removal of unit weights, and (d) repeated application and removal of a load.

S.1.2. INTERCHANGE OR REVERSAL OF PARTS.—Parts of a device that may readily be interchanged or reversed in the course of normal usage shall be so constructed that their interchange or reversal will not materially affect the performance of the device. Parts that may be interchanged or reversed in normal field assembly shall be (a) so constructed that their interchange or reversal will not affect the performance of the device or (b) so marked as to show their proper positions.

S.1.3. PIVOTS.—Pivots shall be of hardened steel, except that agate may be used in prescription scales, and shall be firmly secured in position. Pivot knife-edges shall be sharp and straight, and cone-pivot points shall be sharp.

S.1.4. BEARINGS.—The bearing surface intended for contact with a pivot knife-edge or point shall be smooth and at least as hard as the opposing edge or point. Bearings in the lever systems of scales having nominal capacities of 5,000 pounds or more shall be of hardened steel.

S.1.5. LINES OF CONTACT.—Under all operating conditions, proper lines of contact between knife-edges and their opposing bearings shall be maintained or restored.

S.1.6. ANTIFRICTION ELEMENTS.—At all points at which a live part of the mechanism may come into contact with another part in the course of normal usage, frictional effects shall be reduced to a minimum by means of suitable antifriction elements, opposing surfaces and points being properly shaped, finished, and hardened. A platform scale having a frame around the platform shall be equipped with means to prevent interference between platform and frame.

S.1.7. BALANCE AND LEVEL.

S.1.7.1. ZERO INDICATION.—There shall be a definite and clear zero graduation on an automatic-indicating scale whether or not the entire reading face is graduated, and on a balance indicator, and provision shall be made for giving an indication on either side of the zero graduation sufficient to show clearly an out-of-balance condition.

S.1.7.2. BALANCING MEANS.—A scale shall be provided with means by which the zero-load balance may be adjusted and any loose material used for this purpose shall be securely enclosed. *The balance ball or equivalent device on a large-capacity scale shall not be rotatable and shall be actuated by a self-contained screw unless the balancing device is motor-controlled or otherwise automatic in operation or is enclosed in a cabinet.*

S.1.7.3. ADJUSTMENT.—A mechanical device for adjusting the zero-load balance or the level of a person-weigher or a small-capacity scale other than a cream-test scale, moisture-test scale, jewelers scale, or prescription scale shall be operable or accessible only by mechanical means outside of and entirely separate from the adjustable element, such as a screw driver or wrench but not a pin.

S.1.7.4. LEVEL-INDICATING MEANS.—If the weighing performance of a person weigher, or of a bench or counter scale, is changed by an amount greater than the appropriate acceptance tolerance when it is moved from a level position and rebalanced in a position that is out of level in any direction by 5 percent or approximately 3 degrees, the scale shall be equipped with level-indicating means. *The indications of this level-indicating means shall be readily observable without the necessity of disassembly of any scale parts requiring the use of mechanical means separate from the scale.*

S.1.8. DAMPING MEANS.—An automatic-indicating scale and a balance indicator shall be equipped with effective means for damping the oscillations whenever such means are necessary to bring the indicating elements quickly to rest.

S.1.9. UNIT-WEIGHT MECHANISM.—This shall be constructed to add and remove unit weights one at a time, shall be rapid and positive in its operation, and shall function properly irrespective of the speed of operation.

S.1.10. ADJUSTABLE WEIGHING ELEMENTS.—An adjustable weighing element such as a nose-iron, a pendulum, or a spring (but not an element for adjusting level or zero-load balance) shall be held securely in adjustment and shall not be adjustable from the outside of the scale. *The position of a nose-iron of a large-capacity scale, as determined by the factory adjustment, shall be accurately, clearly, and permanently defined.*

S.1.11. TRAVEL OF PANS OF EQUAL-ARM SCALE.—The travel, between limiting stops, of the pans of a nonautomatic-indicating equal-arm scale not equipped with a balance indicator shall be not less than the minimum travel shown in table 1.

TABLE 1.—MINIMUM TRAVEL OF PANS OF NONAUTOMATIC-INDICATING EQUAL-ARM SCALE WITHOUT BALANCE INDICATOR

Nominal capacity	Minimum travel of pans
Pounds	*Inch*
4 or less	0.35
5 to 12, incl	.5
13 to 26, incl	.75
Over 26	1.0

S.1.12. LOAD-RECEIVING ELEMENTS.

S.1.12.1. HANGING PAN.—This shall be suspended from a ring.

S.1.12.2. HOOK.—A hook may be provided as a load-receiving element only when no other load-receiving element is provided.

S.1.12.3. DRAINAGE.—A load-receiving element intended to receive wet commodities shall be so constructed as to drain effectively.

S.1.12.4. SCOOP COUNTERBALANCE.—A scoop on a scale used for direct sales to retail customers shall not be counterbalanced by a removable weight. A permanently attached scoop-counterbalance shall indicate clearly on both the dealer's and customers' sides of the scale whether it is set for the scoop to be on or off the scale.

S.2. INDICATING MEANS.

S.2.1. SUBDIVISION.—In any series of weight graduations, the values of the graduated intervals shall be uniform throughout the series.

S.2.2. ATTACHMENT.—In any indicator and reading-face combination, the stationary element shall be fixed securely in position and the movable element shall be attached securely to its operating mechanism. However, a movable auxiliary indicator or reading face, adapted to balancing out tare weights and similar uses, may be provided.

S.2.3. WEIGHBEAMS.

S.2.3.1. NORMAL BALANCE POSITION.—The normal balance position of the weighbeam of a beam scale shall be horizontal.

S.2.3.2. TRAVEL.—The weighbeam of a beam scale shall have equal travel above and below the horizontal. The total travel of the weighbeam of a beam scale in a trig loop or between other limiting stops near the weighbeam tip shall be not less than the minimum travel shown in table 2; when such limiting stops are not provided, the total travel at the weighbeam tip shall be not less than 8 percent of the distance from the weighbeam fulcrum to the weighbeam tip.

TABLE 2.—MINIMUM TRAVEL OF WEIGHBEAM OF BEAM SCALE BETWEEN LIMITING STOPS

Distance from weighbeam fulcrum to limiting stops	Minimum travel between limiting stops
Inches	*Inch*
12 or less	0.4
13 to 20, incl	.5
21 to 40, incl	.7
Over 40	.9

S.2.3.3. POISE STOP.—Except on a steelyard with no zero graduation, a shoulder or stop shall be provided on each weighbeam bar to prevent a poise from traveling and remaining back of the zero graduation.

S.2.3.4. SUBDIVISION.—A subdivided weighbeam bar shall be subdivided by means of graduations, notches, or a combination of both. Graduations on a particular bar shall be of uniform width and perpendicular to the top edge of the bar. Notches on a particular bar shall be uniform in shape and dimensions and perpendicular to the face of the bar. When a combination of graduations and notches is employed, the graduations shall be so positioned in relation to the notches as to indicate notch values clearly and accurately.

S.2.3.5. CAPACITY.—*On an automatic-indicating scale having a nominal capacity of* 30 *pounds or less, the capacity of any weighbeam bar shall be a multiple of the reading-face capacity, each bar shall be subdivided throughout or shall be subdivided into notched intervals each equal to the reading-face capacity, and the value of any turnover poise shall be equal to the reading-face capacity.*

S.2.3.6. READABILITY.—A subdivided weighbeam bar shall be so subdivided and marked, and a weighbeam poise shall be so constructed, that the weight corresponding to any normal poise position can easily and accurately be read directly from the beam, whether or not provision is made for the optional recording of representations of weight.

S.2.4. POISES.

S.2.4.1. DESIGN.—No part of a poise shall be readily detachable. A locking screw shall not be removable. Except on a steelyard with no zero graduation, a poise shall not be readily removable from a weighbeam. The bearing edge of a hanging poise shall be hard and sharp and so constructed as to allow the poise to swing freely in the weighbeam notches.

S.2.4.2. ADJUSTING MATERIAL.—The adjusting material in a poise shall be securely enclosed and firmly fixed in position, and if softer than brass it shall not be in contact with the weighbeam.

S.2.4.3. PAWL.—A poise, other than a hanging poise, on a notched weighbeam bar shall have a pawl with a rounded tip that will seat the poise in a definite and correct position in any notch, wherever in the notch the pawl is placed, and hold it there firmly and without appreciable movement. That dimension of the tip of the pawl that is transverse to the longitudinal axis of the weighbeam shall be equal to the corresponding dimension of the notches.

S.2.4.4. READING EDGE OR INDICATOR.—The reading edge or indicator of a poise shall be sharply defined, and a reading edge shall be parallel to the graduations on the weighbeam.

S.2.5. INDICATORS ON AUTOMATIC-INDICATING SCALES.—When an indicator extends along the entire length of a graduation, that portion of the indicator that may be brought into coincidence with the graduation shall be of the same width throughout.

S.2.6. UNIT-WEIGHT INDICATIONS AND REPRESENTATIONS.—The total value of the unit weights in place at any time shall automatically be shown on the reading face. A recorded weight representation of a scale employing unit weights shall include the total value of any unit weights involved in the weighing.

S.2.7. BALANCE INDICATOR.—In a balance indicator consisting of two indicating edges, lines, or points, the ends of the indicators shall be sharply defined and shall be separated by not more than 0.04 inch, measured horizontally, when the scale is in balance.

S.3. INSTALLATION.

S.3.1. PROTECTION AGAINST WIND AND WEATHER EFFECTS.—The indicating elements, the lever system, and the under side of the load-receiving element of a scale shall be adequately protected against wind and weather effects.

S.3.2. FOUNDATION, ALINEMENT, AND CLEARANCES.—The foundations and supports of any scale installed in a fixed location shall be such as to insure adequate strength, rigidity, and permanence, all working parts shall be in proper condition as to level and vertical alinement, and adequate clearances shall be provided around all live parts.

S.3.3. ACCESS TO PIT.—*Adequate provision shall be made for ready access to the pit of a vehicle or livestock scale for purposes of inspection and maintenance.*

S.4. MARKING.

S.4.1. NOMINAL CAPACITY.—*The nominal capacity shall be conspicuously marked (a) on any scale equipped with unit weights, (b) on any scale with which counterpoise or equal-arm weights are intended to be used, and (c) on any automatic-indicating or recording scale so constructed that the capacities of the several individual indicating and recording elements are not immediately apparent.*

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO COMPUTING SCALES

S.10. VALUE GRADUATIONS AND GRADUATED INTERVALS.—The value of the graduated intervals representing money values on a computing scale shall be (a) not more than 1 cent at all unit prices of 30 cents per pound and less, and (b) not more than 2 cents at all higher unit prices. However, special graduations defining 5-cent intervals may be employed, but not in the spaces between regular graduations. Value figures and graduations shall not be duplicated in any column or row on a chart.

S.11. CUSTOMERS' INDICATIONS.—Weight indications shall be shown on the customers' side of a computing scale.

S.12. READABILITY.—A computing scale shall be so constructed as to disclose a sufficient number of weight graduations on the customers' side and a sufficient number of weight and money-value graduations on the dealer's side, so that at any time the weight and value indications of the scale can be accurately read.

S.13. PREPACKAGING SCALE.—A prepackaging scale shall be conspicuously marked on the operator's side and on the opposite side with the words "For Prepackaging Use Only" or with a similar and suitable statement, and shall be exempt from the requirements of S.11. and, if "customers' weight indications" are not provided, from the requirements of S.12. that relate to customers' weight indications. A prepackaging scale may be equipped with an auxiliary, manually-operable balancing device if this is so designed that it will operate only in a backward direction (that is, in the direction of underregistration) with respect to the balance condition established by the primary, mechanically-operable balancing device of the scale.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO PRESCRIPTION, JEWELERS, CREAM-TEST, AND MOISTURE-TEST SCALES

S.20. BALANCE INDICATOR.—A prescription, jewelers, cream-test, or moisture-test scale shall be equipped with a balance indicator; if this consists of an indicator and a graduated scale that are not in the same plane, the clearance between the indicator and the graduations shall be not more than 0.04 inch.

S.21. ARRESTING MEANS.—A prescription or jewelers scale shall be equipped with mechanical means for arresting the oscillation of the mechanism.

S.22. MARKING OF CLASS B PRESCRIPTION SCALES.—A prescription scale that fails to meet the performance requirements for Class A scales but does meet the performance requirements for Class B scales shall be conspicuously marked with the words "Class B. Not to be used in weighing loads of less than 10 grains", or with a similar and suitable statement conveying the same information.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO PERSON WEIGHERS

S.30. NOMINAL CAPACITY.—A person weigher shall have a nominal capacity of not less than 250 pounds.

S.31. ZERO-LOAD BALANCE INDICATION.—A person weigher shall have a definite and clear zero graduation, and an automatic-indicating or ticket person weigher shall be capable of giving a zero-load balance indication throughout a zone corresponding to not less than 5 pounds on either side of the zero graduation.

S.32. WEIGHT INDICATIONS AND REPRESENTATIONS.—The value of the minimum graduated interval on a person weigher shall be not greater than 1 pound. On a person weigher other than a ticket person weigher, weight indications shall be shown from zero to capacity, except that there may be an interval between zero and some definite weight value throughout which weight indications are not shown if, whenever a weighing within this interval is attempted, any coin inserted is automatically returned to a suitable receptacle on the outside of the person weigher or the insertion of a coin in the coin slot is automatically prevented. On a ticket person weigher, there may be an interval between zero and a definite weight value throughout which tickets are not given if, whenever a weighing within this interval is attempted, any coin inserted is returned or the insertion of a coin is prevented as prescribed in this paragraph, or if the weight is shown on a reading face.

S.33. PRINTING OF TICKET.—On a ticket person weigher, the transfer of the weight record to the ticket shall not be made until the weighing mechanism has had ample opportunity, under normal person-weighing conditions, to come to rest.

S.34. EXHAUSTION OF TICKET SUPPLY.—Throughout any period during which the supply of tickets on a ticket person weigher is exhausted, any coin inserted shall automatically be returned to a suitable receptacle on the outside of the person weigher or the insertion of a coin in the coin slot shall automatically be prevented.

S.35. PROVISION FOR SEALING COIN SLOT.—*Provision shall be made on a coin-operated person weigher for applying a lead-and-wire seal in such a way that insertion of a coin in the coin slot will be prevented.*

S.36. MARKING.—A person weigher that may give inaccurate results except when special precautions are observed shall be marked conspicuously and permanently with suitable and explicit instructions.

NOTES, PERFORMANCE REQUIREMENTS, AND REGULATIONS APPLICABLE TO ALL CLASSES OF SCALES

N. NOTES.

N.1. TESTING PROCEDURES.

N.1.1. TEST WITH INCREASING LOADS.—This test shall be made on all scales, with the test loads approximately centered on the load-receiving element of the scale except on a scale having a nominal capacity greater than the total available known test load, in which case the available test load is used to greatest advantage by concentrating it, within prescribed load limits, over the main load supports of the scale.

N.1.2. TEST WITH DECREASING LOADS.—This test shall be made on automatic-indicating scales only, with the test loads approximately centered on the load-receiving element of the scale.

N.1.3. SHIFT TEST.

N.1.3.1. GENERAL.—The shift test shall be made on all scales except hanging scales, and shall be made with a half-capacity load whenever practicable unless a different shift-test load is prescribed.

N.1.3.2. ON SCALE WITH STABILIZED LOAD-RECEIVING ELEMENT.—On a scale in which the load-receiving element is mounted on two main load supports and is maintained in position by means of a stabilizing linkage, a half-capacity shift-test load shall be centered successively at the center of the load-receiving element and at not less than four equidistant points halfway between the center and the edge of the load-receiving element.

N.1.3.3. ON SCALE WITH FOUR MAIN LOAD SUPPORTS.—On a scale in which the load-receiving element is mounted on four main load supports, a quarter-capacity load shall be centered, as nearly as may be, successively over each main load support, or a half-capacity load shall be centered, as nearly as may be, successively at the center of each quarter of the load-receiving element. However, on a two-section vehicle scale, a half-capacity load or more may be concentrated successively across the two ends of the platform in lieu of the general procedure prescribed. Also, on a four-section vehicle scale, tests shall be made at each section corresponding to the corner or end tests on a two-section scale.

N.1.3.4. ON EQUAL-ARM SCALE.—On an equal-arm scale, the position of a half-capacity load shall be shifted, as prescribed in N.1.3.2., on each pan, and observations shall be made at various combinations of positions on the two pans in order to develop the maximum shift-test error.

N.1.3.5. ON CREAM-TEST OR MOISTURE-TEST SCALE.—The shift test shall be made with a load of 18 grams, this load being successively positioned at all points at which a weight might reasonably be placed in the course of normal use of the scale.

N.1.4. MINIMUM TEST-WEIGHT LOAD FOR RAILWAY TRACK SCALE.—In the test of a railway track scale, the test-weight load shall be not less than 30,000 pounds.

N.1.5. SR DETERMINATIONS.—These shall be made in connection with the test with increasing loads, but only on nonautomatic-indicating scales. Determinations shall be made at zero load and at the maximum load applied to the scale, and, preferably, also at a load intermediate between zero and maximum load. On a cream-test scale, for the SR determination at maximum load, the pan or pans shall bear a centrally-positioned load or loads equal to 2 avoirdupois ounces multiplied by the number of test bottles that the pan or pans will accommodate. On a moisture-test scale, for the SR determination at maximum load, the pan or pans shall bear a centrally-positioned load or loads of 2 avoirdupois ounces. An automatic-indicating element or a balance indicator that is purely auxiliary to a primarily nonautomatic-indicating scale, and that may or may not be employed at the option of the operator, shall not exempt the scale from the SR requirements when the automatic-indicating element or balance indicator is disconnected or detached; SR determinations may be made on such a scale with the automatic-indicating element or balance indicator disconnected or detached, and if such scale is one in which the weighbeam travel is in excess of that required by S.2.3.2., the SR determination shall be based upon the weighbeam travel required by S.2.3.2.

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P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. SR REQUIREMENTS.

P.1.1. FOR SMALL-CAPACITY SCALES.

P.1.1.1. GENERAL.—The maximum maintenance SR, except as prescribed in P.1.1.2., P.1.1.3., and P.1.1.4., shall be the appropriate value shown in table 4, or the value of two of the minimum graduated intervals on the weighbeam, whichever is less. The maximum acceptance SR shall be one-half the maximum maintenance SR.

TABLE 4.—MAXIMUM MAINTENANCE SR ON SMALL-CAPACITY SCALES EXCEPT PRESCRIPTION SCALES, JEWELERS SCALES, CREAM-TEST SCALES, AND MOISTURE-TEST SCALES

Nominal capacity	Maximum SR
Pounds	*Ounces*
3 or less	1/8
4 to 7, incl	1/4
8 to 14, incl	1/2
15 to 23, incl	3/4
24 to 39, incl	1
40 to 49, incl	1 1/4
50 to 74, incl	1 1/2
75 to 89, incl	2
90 to 99, incl	2 1/2
100 and over	3

P.1.1.2. FOR CLASS A PRESCRIPTION SCALES AND JEWELERS SCALES.—The maximum maintenance SR shall be 0.2 grain (13 milligrams), or the value of two of the minimum graduated intervals on the weighbeam, whichever is less. The maximum acceptance SR shall be one-half the maximum maintenance SR.

P.1.1.3. FOR CLASS B PRESCRIPTION SCALES.—The maximum maintenance SR shall be 0.5 grain (32 milligrams). The maximum acceptance SR shall be one-half the maximum maintenance SR.

P.1.1.4. FOR CREAM-TEST SCALES.—The maximum maintenance and acceptance SR shall be 0.5 grain (32 milligrams).

P.1.1.5. FOR MOISTURE-TEST SCALES.—The maximum maintenance SR shall be 0.5 grain (32 milligrams). The maximum acceptance SR shall be one-half the maximum maintenance SR.

P.1.2. FOR LARGE-CAPACITY SCALES.

P.1.2.1. GENERAL.—The maximum maintenance SR, except as prescribed in P.1.2.2. and P.1.2.3., shall be the value of two of the minimum graduated intervals on the weighbeam, or 40 pounds, whichever is less. The maximum acceptance SR shall be one-half the maximum maintenance SR.

P.1.2.2. FOR VEHICLE SCALES.—The maximum maintenance SR shall be 10 pounds, or the value of two of the minimum graduated intervals on the weighbeam, whichever is greater. The maximum acceptance SR shall be one-half the maximum maintenance SR.

P.1.2.3. FOR RAILWAY TRACK SCALES.—The maximum maintenance SR on a scale in grain-weighing service shall be 50 pounds, and on any other scale shall be 100 pounds. On any scale the maximum acceptance SR shall be 50 pounds.

T. TOLERANCES. (See also G–T.5. and G–T.6.)

T.1. FOR SMALL-CAPACITY SCALES.

T.1.1. APPLICATION.

T.1.1.1. TO INCREASING-LOAD TESTS.—Basic tolerances shall be applied.

T.1.1.2. TO SHIFT TESTS.—Basic tolerances shall be applied.

T.1.1.3. TO DECREASING-LOAD TESTS ON AUTOMATIC-INDICATING SCALES.—Twice the basic tolerances shall be applied.

T.1.2. MINIMUM TOLERANCE VALUES.

T.1.2.1. ON NONAUTOMATIC-INDICATING SCALES EXCEPT PRESCRIPTION, CREAM-TEST, AND MOISTURE-TEST SCALES.—On a particular scale, the maintenance tolerances applied shall be not smaller than one-half the value of the minimum graduated interval on the weighbeam or, if the scale is not equipped with a weighbeam, not smaller than the "Minimum tolerance value" shown in table 5 for a scale of the capacity in question. The acceptance tolerances applied shall be not smaller than one-fourth the value of the minimum graduated interval on the weighbeam or, if the scale is not equipped with a weighbeam, not smaller than one-half the appropriate "Minimum tolerance value" shown in table 5.

TABLE 5.—MINIMUM MAINTENANCE TOLERANCE VALUES FOR SMALL-CAPACITY NONAUTOMATIC-INDICATING SCALES NOT EQUIPPED WITH WEIGHBEAMS, EXCEPT PRESCRIPTION, CREAM-TEST, AND MOISTURE-TEST SCALES

Nominal capacity	Minimum tolerance value
Pounds	*Ounce*
3 or less	1/16
4 to 7, incl	1/8
8 to 14, incl	1/4
15 to 23, incl	3/8
24 to 39, incl	1/2
40 to 50, incl	5/8

T.1.2.2. ON AUTOMATIC-INDICATING SCALES.—On a particular scale, the maintenance tolerances applied shall be not smaller than one-fourth the value of the minimum graduated interval on the reading-face. The acceptance tolerances applied shall be not smaller than one-eighth the value of the minimum graduated interval on the reading-face. However, on a prepackaging scale (see D.11.) having graduated intervals of less than one-half ounce, the maintenance tolerances applied shall be not smaller than one-eighth ounce and the acceptance tolerances applied shall be not smaller than one-sixteenth ounce.

T.1.3. BASIC TOLERANCE VALUES.

T.1.3.1. FOR SMALL-CAPACITY SCALES EXCEPT UNCOMPENSATED SPRING SCALES, PRESCRIPTION SCALES, JEWELERS SCALES, CREAM-TEST SCALES, AND MOISTURE-TEST SCALES.—Basic maintenance tolerances for small-capacity scales except uncompensated spring scales, prescription scales, jewelers scales, cream-test scales, and moisture-test scales, on underregistration and on overregistration, shall be as shown in table 6. Basic acceptance tolerances shall be one-half the basic maintenance tolerances. [Effective July 1, 1957, the words "uncompensated spring scales" in the side title and text of this paragraph and in the heading of table 6 shall be deleted.]

TABLE 6.—BASIC MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR SMALL-CAPACITY SCALES, EXCEPT UNCOMPENSATED SPRING SCALES, PRESCRIPTION SCALES, JEWELERS SCALES, CREAM-TEST SCALES, AND MOISTURE-TEST SCALES

Known test load	Tolerance on ratio test	Tolerance on weigh-beam, reading-face, and unit-weight indications
Pounds	*Ounce*	*Ounces*
1	1/16	1/16
2 and 3	1/16	1/8
4 to 7, incl	1/8	3/16
8 to 14, incl	1/4	3/8
15 to 23, incl	5/16	1/2
24 to 29, incl	3/8	1/2
30 to 39, incl	3/8	5/8
40 to 49, incl	7/16	5/8
50 to 59, incl	1/2	3/4
60 to 74, incl	5/8	1
75 to 89, incl	3/4	1
90 to 99, incl	7/8	1 1/4
100 and over	1 oz per 100 lb	1 1/2 oz per 100 lb

T.1.3.2. FOR UNCOMPENSATED SPRING SCALES.—Effective only until July 1, 1957, basic maintenance tolerances for small-capacity uncompensated spring scales, on underregistration and on overregistration, shall be as shown in table 7. Basic acceptance tolerances shall be one-half the basic maintenance tolerances. [Effective July 1, 1957, this paragraph, including table 7, is rescinded.]

TABLE 7.—BASIC MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR SMALL-CAPACITY UNCOMPENSATED SPRING SCALES

Known test load	Tolerance, except for straight-face spring scales	Tolerance for straight-face spring scales
Pounds	*Ounces*	*Ounces*
1	1/8	1/2
2 and 3	1/4	1
4 to 7, incl	1/2	2
8 to 11, incl	3/4	3
12 to 19, incl	1	4
20 to 29, incl	11/2	6
30 to 49, incl	2	8
50 to 74, incl	3	12
		Pound
75 to 100	4	1
Over 100	4 oz per 100 lb	1 lb per 100 lb

T.1.3.3. FOR PRESCRIPTION AND JEWELERS SCALES.—Basic maintenance and acceptance tolerances for prescription and jewelers scales, on underregistration and on overregistration, on ratio test, shall be as shown in table 8. The maintenance and acceptance tolerance on any weighbeam indication, on underregistration and on overregistration, shall be the value of the minimum graduated interval on the weighbeam. (On a Class A prescription scale, the nominal capacity shall, in the absence of information to the contrary, be assumed to be ½ apothecaries ounce.)

TABLE 8.—BASIC MAINTENANCE AND ACCEPTANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, ON RATIO TESTS OF PRESCRIPTION AND JEWELERS SCALES

Known test load		Tolerance on ratio test			
		For Class A prescription scales and jewelers scales		For Class B prescription scales	
Ounces apoth	*Grams*	*Grains*	*Milligrams*	*Grains*	*Milligrams*
1/2	15	0.2	13	0.5	30
1	30	.4	26	1.0	65
2	60	.8	52	2.0	130
4	120	1.6	104	4.0	260
8	240	----------	--------	8.0	520

T.1.3.4. FOR CREAM-TEST AND MOISTURE-TEST SCALES.—The basic maintenance tolerance for cream-test and moisture-test scales (applied on an 18-gram load), on underregistration and on overregistration, shall be 0.5 grain (32 milligrams). The basic acceptance tolerance shall be one-half the basic maintenance tolerance.

T.2. FOR LARGE-CAPACITY SCALES.

T.2.1. APPLICATION.

T.2.1.1. TO INCREASING-LOAD TESTS.—Basic tolerances shall be applied.

T. 2.1.2. TO SHIFT TESTS.—On a scale other than a vehicle scale, basic tolerances shall be applied. On a vehicle scale the tolerances on corner tests shall be twice the basic tolerances, but on a corner test at a particular load, the algebraic mean of the errors on the two corners at each end of the scale shall be not greater than the basic tolerance for the load in question.

T.2.1.3. TO DECREASING-LOAD TESTS ON AUTOMATIC-INDICATING SCALES.—Twice the basic tolerances shall be applied.

T.2.2. MINIMUM TOLERANCE VALUES.—On a particular scale, the maintenance tolerances applied shall be not smaller than the value of the minimum graduated interval on the weighbeam (for a nonautomatic-indicating scale) or on the reading-face (for an automatic-indicating scale). The acceptance tolerances applied shall be not smaller than one-half the value of the minimum graduated interval on the weighbeam (for a nonautomatic-indicating scale) or on the reading-face (for an automatic-indicating scale).

T.2.3. BASIC TOLERANCE VALUES.

T.2.3.1. FOR LARGE-CAPACITY SCALES EXCEPT LIVESTOCK, COAL-MINE, VEHICLE, WHEEL-LOAD, AXLE-LOAD, AND FREIGHT SCALES, WHEEL-LOAD WEIGHERS, AND RAILWAY TRACK SCALES.—Basic maintenance tolerances for large-capacity scales except livestock, coal-mine, vehicle, wheel-load, axle-load, and freight scales, wheel-load weighers, and railway track scales, on underregistration and on overregistration, shall be as shown in table 9. Basic acceptance tolerances shall be one-half the basic maintenance tolerances.

TABLE 9.—BASIC MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR LARGE-CAPACITY SCALES, EXCEPT LIVESTOCK, COAL-MINE, VEHICLE, WHEEL-LOAD, AXLE-LOAD, AND FREIGHT SCALES, WHEEL-LOAD WEIGHERS, AND RAILWAY TRACK SCALES

Known test load	Tolerance on ratio test	Tolerance on weighbeam, reading-face, and unit-weight indications
Pounds	*Ounces*	*Ounces*
99 or less	1/2	1
100 to 199, incl	2	2
200 to 299, incl	3	4
300 to 399, incl	4	6
400 to 499, incl	5	8
500 to 599, incl	7	10
600 to 799, incl	8	12
		Pound
800 to 999, incl	11	1
1,000 and over	3/4 lb per 1,000 lb	1 lb per 1,000 lb

T.2.3.2. FOR LIVESTOCK, COAL-MINE, VEHICLE, WHEEL-LOAD, AXLE-LOAD, AND FREIGHT SCALES.—Basic maintenance tolerances for livestock, coal-mine, vehicle, wheel-load, and axle-load scales, and for scales used exclusively in determining charges for freight transportation, on underregistration and on overregistration, shall be 1½ pounds per 1,000 pounds of test load on ratio tests and 2 pounds per 1,000 pounds of test load on weighbeam, reading-face, and unit-weight indications. Basic acceptance tolerances shall be one-half the basic maintenance tolerances.

T.2.3.3. FOR WHEEL-LOAD WEIGHERS.—The basic maintenance tolerance for individual wheel-load weighers, on underregistration and on overregistration, shall be 3 percent of the known test load. The basic acceptance tolerance on underregistration and on overregistration shall be 2 percent of the known test load. When two wheel-load weighers are tested as a pair, the tolerance shall be applied to the sum of the indications of the two weighers, and the pair shall be approved or rejected upon the basis of the combined indications.

T.2.3.4. FOR RAILWAY TRACK SCALES.[7]

1. *Test loads.*—The test loads used consist of standard test weights carried on a 4-wheel truck of known weight having a wheel base of 5 feet.

2. *Test-load positions.*—A section of a railway track scale comprises a pair of main levers (straight-lever type), or a single main lever (torsion-lever type). The location of a section is defined by a vertical plane passing through the midpoints of its load knife-edges. Sections are designated as 1, 2, 3, etc., being numbered from the left to the right of an observer at the weighbeam facing the scale deck.

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[7] The tolerances for railway track scales are here presented, together with associated text, in the form in which they have been published by the National Bureau of Standards, instead of in the standard form used elsewhere herein. It should be noted that this material is based upon the testing equipment utilized, and the procedures followed, by the National Bureau of Standards in its testing of railway track scales. It is not to be inferred that satisfactory routine testing of railway track scales cannot be carried out with types of testing equipment other than the one herein described and by following procedures differing in certain respects from those herein set forth.

A test run comprises normal positions of the test load assumed when each pair of wheels of the truck is successively positioned over each section of the scale (except at each end section, where only one truck position is possible), except that in the case of a two-section scale an additional position is utilized with the center of the truck midway between the sections, a position designated as "Center". Sectional positions are designated as 1R, 2L, 2R, 3L, etc., the number denoting the section and the letter denoting that the body of the truck lies to the right or to the left of the section. Any position offset from a normal position is designated by its distance to the right (+) or to the left (—) of the nearest normal position; thus the position 1R + 10″ is 10 inches to the right of position 1R.

3. *Method of test.*—The normal test consists of test runs made with loads of 40,000 pounds and 80,000 pounds, two runs in opposite directions being made with each load. For a scale to which is attached an automatic-indicating or recording device, tests are made with the device attached and with the device detached.

4. *Character of error.*—The amount by which the scale indication differs from the actual value of the applied test load is the error of the scale for the given position and load. A plus (+) sign denotes that the weight indication exceeds the value of the test load; a minus (—) sign denotes the converse.

5. *Maximum indicated percentage error of weighing.*—The "maximum indicated percentage error of weighing" is computed for scales of more than two sections, and is the largest mean value which can be derived from two errors developed during a single test run for positions (1) not closer together than the distance between adjacent sections on all scales except those in grain-weighing service or (2) farther apart than the distance between adjacent sections on all scales in grain-weighing service.

6. *Tolerances.* I. The tolerances adopted by the Bureau for all railway track scales not equipped with automatic indicating or recording devices and for these latter scales while such devices are detached, are as follows:

A. The maintenance tolerance (applicable to scales in use) for all scales except those in grain-weighing service, is ±0.20 percent of the test load being utilized, applied as follows:

(1) For a scale of more than two sections, to the maximum indicated percentage error of weighing as defined above, but with the added requirement that no individual sectional error shall exceed 0.30 percent of the test load being utilized.

(2) For a scale of more than two sections, to the maximum individual percentage error developed when two or more test loads are applied to the scale at the same time at normal positions not closer together than the distance between adjacent sections.

(3) For a two-section scale, to the maximum individual percentage error developed for any position of the test load or loads.

B. The maintenance tolerance (applicable to scales in use) for scales in grain-weighing service is ± 0.10 percent of the test load being utilized, applied as follows:

(1) For a scale of more than two sections, to the maximum indicated percentage error of weighing as defined above.

(2) For a scale of more than two sections, to the maximum individual percentage error developed when two or more test loads are applied to the scale at the same time and at normal positions which are farther apart than the distance between adjacent sections.

(3) For a two-section scale, to the maximum individual percentage error developed for any position of the test load or loads.

NOTE.—The tolerance for scales in grain-weighing service was adopted pursuant to the recommendations of the Interstate Commerce Commission (Docket No. 9009; 56 ICC 347). These recommendations also contain a provision that a scale shall be corrected whenever a test discloses an error in excess of 0.10 percent for any position of a test load; this provision will be adhered to by the Bureau in its recommendations.

C. The acceptance and adjustment tolerance (applicable to new or newly reconditioned scales) for all scales is ± 0.05 percent of the test load being utilized, applied to the maximum individual percentage error developed for any position of the test load.

II. The tolerances adopted by the Bureau for all railway track scales in which are embodied or to which are attached automatic indicating or recording devices, for the respective types of scales and conditions of test, are the same as those for scales independent of such devices, except as follows:

A. If the weight is indicated on a reading face, or by means of a printed impression showing the position of an indicating line with reference to a series of graduations, the maintenance tolerance shall not be less than the value of the minimum graduation on the reading face or printed impression, or of one five-hundredth of the capacity of the automatic device, whichever is the smaller value, and the acceptance and adjustment tolerance shall not be less than one-half the minimum specified for the maintenance tolerance.

B. If the weight indication is a printed record comprising figures only, there shall be added to the tolerance which would otherwise be appropriate, an amount equal to 50 percent of the value of the increment between indications that can be printed by the device, or 50 pounds, whichever value is the smaller.

R. REGULATIONS.

R. 1. BALANCE CONDITION.—A scale shall be maintained in balance.

R. 2. SUPPORTS AND LEVEL CONDITION.—A scale that is portable and that is being used on a counter or table or on the floor shall be so positioned that it is firmly and securely supported, and the scale shall be maintained in level.

R. 3. SUSPENSION OF HANGING SCALE.—A hanging scale shall be freely suspended from a fixed support when in use.

R. 4. VALUE OF MINIMUM GRADUATED INTERVAL.

R.4.1. ON FOOD SCALES.—The value of the minimum graduated interval on a scale used for the retail sale of foodstuffs shall be not greater than 1 ounce.

R.4.2. ON LIVESTOCK SCALES.—The value of the minimum graduated interval on the main-weighbeam elements, on the tare-weighbeam elements, *and on the reading-face elements* of a livestock scale shall be not greater than 5 pounds. *However, the reading face of any tell-tale attachment auxiliary to a weighbeam shall be uniformly graduated into intervals of 5 pounds or less, 100 pounds, or some integral multiple of 100 pounds, and no others.*

R.4.3. ON ANIMAL SCALES.—*The value of the minimum graduated interval on the weighbeam elements and on the reading-face elements of an animal scale shall be not greater than 1 pound.*

R.4.4. ON VEHICLE, WHEEL-LOAD, AND AXLE-LOAD SCALES.—*The value of the minimum graduated interval on the main-weighbeam elements, on the tare-weighbeam elements, and on the reading-face elements of a vehicle, wheel-load, and axle-load scale shall be not greater than 20 pounds. However, the reading face of any tell-tale attachment auxiliary to a weighbeam shall be uniformly graduated into intervals of 20 pounds or less, 100 pounds, or some integral multiple of 100 pounds, and no others.*

R.4.5. ON HAND-OPERATED GRAIN HOPPER SCALES.—*The value of the minimum graduated interval on the weighbeam elements and on the reading-face elements of a hand-operated grain hopper scale shall be not greater than 5 pounds.*

R.5. UNCOMPENSATED SPRING SCALES.—An uncompensated spring scale shall not be used for the sale of foodstuffs other than fruits and vegetables. [Effective July 1, 1957, this paragraph is rescinded.]

R.6. WEIGHING OF WET COMMODITIES.—Wet fish and other wet commodities shall be weighed only on scales on which the pans or platforms will drain properly.

R.7. LADING.—A scale shall not be used for weighing a load totaling more than the nominal capacity of the scale. A vehicle scale shall not be used for weighing a load smaller than 1,000 pounds.

R.8. CLASS B PRESCRIPTION SCALE.—A Class B prescription scale shall not be used for weighing loads smaller than 10 grains, and may be used for prescription work only when a Class A prescription scale is provided at the same establishment.

R.9. APPROACHES TO VEHICLE SCALES.—At each end of a vehicle scale there should be a straight approach in the same plane as the platform for a distance equal to at least the length of the scale platform or 40 feet, whichever is less.

R.10. APPROACHES TO WHEEL-LOAD AND AXLE-LOAD SCALES.—At each end of a wheel-load or axle-load scale there shall be a straight approach in the same plane as the platform, of sufficient length and width to insure the level positioning of vehicles during weight determinations.

R.11. STOCK RACKS.—A livestock or animal scale shall be equipped with a suitable enclosure, fitted with gates as required, within which livestock may be held on the scale platform. This rack shall be securely mounted on the scale platform, and adequate clearances shall be maintained around the outside of the rack.

R.12. LENGTHENING OF PLATFORMS.—The length of the platform of a vehicle scale or livestock scale shall not be increased beyond the manufacturer's designed dimension except when the modification has been approved by competent scale-engineering authority, preferably that of the engineering department of the manufacturer of the scale, and by the weights and measures authority having jurisdiction over the scale.

R.13. READABILITY OF RECORDED REPRESENTATIONS OF PERSON WEIGHERS.—A ticket person weigher shall be so maintained in use that all representations of weight transferred to the weight ticket during operation of the weigher shall be clear and distinct.

R.14. OWNERSHIP IDENTIFICATION ON PERSON WEIGHER.—A person weigher shall be legibly and permanently marked to show the name and address of the person, firm, or corporation responsible for placing it in service, in combination with some such words as "Operated by" or "Maintained by". However, such statement shall not be required when the person weigher is in service on the premises of such person, firm, or corporation.

R.15. MARKING OF WHEEL-LOAD WEIGHERS.—When wheel-load weighers are regularly used in pairs, each weigher of each such pair shall be appropriately marked to identify them as weighers intended to be used in combination.

R.16. ACCESSIBILITY FOR TESTING PURPOSES.—A large-capacity scale shall be so located, or such facilities for normal access thereto shall be provided, that the test weights of the weights and measures official, in the denominations customarily provided, and in the amount deemed necessary by the weights and measures official for the proper testing of the scale, may readily be brought to the scale by customary means. Otherwise it shall be the responsibility of the scale owner or operator to supply such special facilities, including necessary labor, as may be required to transport the test weights to and from the scale, for testing purposes, as required by the weights and measures official.

R.17. ASSISTANCE IN TESTING OPERATIONS.—If the design, construction, or location of a large-capacity scale is such as to require a testing procedure involving special accessories or an abnormal amount of handling of test weights, such accessories and needed assistance in the form of labor shall be supplied by the owner or operator of the scale, as required by the weights and measures official.

R.18. PREPACKAGING SCALE.—A scale marked with the words "For Prepackaging Use Only" or with a statement of similar meaning, shall be used only for putting up packages in advance of sale and shall not be used for direct sales to retail customers.

R.19. SINGLE-DRAFT VEHICLE WEIGHING.—Effective July 1, 1957, a highway vehicle or a coupled highway-vehicle combination shall be commercially weighed on a vehicle scale only as a single draft; that is, the total weight of such a vehicle or combination shall not be determined by adding together the results obtained by separately weighing each end of such vehicle, or by separately weighing individual elements of such vehicle or coupled combination.

WEIGHTS

GENERAL CODE REFERENCES.—See general specifications G–S.2., G–S.3., and G–S.6. See also general regulations G–R.2., G–R.3., and G–R.4.

A. APPLICATION.

A.1.—This code does not apply to test weights or other "standards" of mass.

D. DEFINITIONS.

D.1. EQUAL-ARM WEIGHT.—One designed for use on a scale with a nominal multiple of 1.

D.2. COUNTERPOISE WEIGHT.—A slotted or "hanger" weight intended for application near the tip of the weight-beam of a scale having a multiple greater than 1.

D.3. POINT.—One one-hundredth of a carat, or 2 milligrams.

S. SPECIFICATIONS.

S.1. MATERIAL.—A weight shall be made of a metal or alloy not softer than brass, except that a weight of less than 100 grains (of whatever system) shall not be made of iron or steel and may be made of aluminum.

S.2. DESIGN.—The surface of a weight shall be smooth. A weight of a value of more than 30 grains (of whatever system) shall not have sharp points or corners. A ring on a weight shall not be split or removable. Adjusting material shall be securely positioned and shall not project beyond the surface of the weight.

S.3. FINISH.—A weight shall not be coated with thick, soft, or brittle material.

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S.4. MARKING.—A weight shall be marked to show clearly its nominal value, and a counterpoise weight shall, in addition, be marked to show clearly the value it represents when used on the multiplying-lever scale for which it is intended. In the case of weights of the troy and apothecaries systems the nominal values of which are expressed in terms of pounds and ounces, and in the case of weights of the apothecaries system the nominal values of which are expressed in terms of drams, the identifying letters "t" and "ap" shall be used in combination with the designations of nominal values for weights in the troy and apothecaries systems, respectively, whenever the weights are not so small as to make this impracticable. In the case of weights of the metric system, nominal values shall be expressed in terms of kilograms, grams, and milligrams only; the abbreviations "kg", "g", and "mg", respectively, shall be employed. Nominal values of carat weights shall be expressed in terms of carats; the abbreviation "c" shall be employed. However, the nominal value of a weight of 30 grains or less (of whatever system) may be designated by dots, lines, figures, distinctive shape, or other appropriate means.

T. TOLERANCES.

T.1.—The maintenance tolerances in excess and in deficiency for commercial avoirdupois weights, for commercial troy weights, for commercial carat weights, for weights used in connection with prescription scales, and for weights used in connection with cream-test and moisture-test scales shall be, respectively, as shown in tables 1, 2, 3, 4, and 5. Accepted tolerances shall be one-half the maintenance tolerances.

TABLE 1.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR COMMERCIAL AVOIRDUPOIS WEIGHTS

Nominal value	Tolerance		
	Equal-arm weights	Counterpoise weights	
		For scales with multiples of less than 1000	For scales with multiples of 1000 and over
Ounces	*Grains*	*Grains*	*Grains*
1/64	0.2	----	----
1/32 to 1/8, incl	.5	----	----
1/4	1.0	----	----
1/2 and 1	2.0	1	----
2	3.0	1	----
4	4.0	2	1.0
5	5.0	2	1.0
8	7.0	3	1.5
10	8.0	4	2.0
Pounds			
1	10.0	5	2.5
2	15.0	8	4.0
3	20.0	10	5.0
4	25.0	12	6.0
5	25.0	13	6.5
8	30.0	18	9.0
10	40.0	20	10.0
15	40.0	----	----
20	60.0	----	----
25	70.0	----	----
50	100.0	----	----

TABLE 2.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR COMMERCIAL TROY WEIGHTS

Nominal value	Tolerance
Pennyweights	*Grains*
1	0.15
2	.25
3	.3
4	.4
5	.5
10	.7
Ounces troy	
1	1.0
2 to 4, incl	2.0
5 and 8	3.0
10 and 12	4.0

TABLE 3.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR COMMERCIAL CARAT WEIGHTS

Nominal value	Tolerance
Carats	*Milligrams*
0.25 (25 points) or less	0.5
0.5 (50 points)	.7
1	1.0
2	1.5
5	2.0
10	3.0
20	5.0
50	7.0
100	10.0

TABLE 4.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR PRESCRIPTION WEIGHTS

Nominal value	Tolerance	Nominal value	Tolerance
Grains	*Grains*	*Milligrams*	*Milligrams*
5 or less	0.02	50 or less	1
10	.04	100	1.5
20	.06	200	2
		500	3
Scruples		*Grams*	
1	.06		
2	.1	1	4
		2	6
Drams, Apoth.		5	10
		10	15
0.5	.08	20	20
1	.1		
2	.15	50	40
3	.2	100	60
		200	80
4	.25	500	140
5	.3		
6	.35		
Ounces, Apoth.			
1	.4		
2	.5		
3	.6		
4	.8		
5	1.0		
6	1.2		
8	1.5		
10	2.0		
12	2.0		

TABLE 5.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR CREAM-TEST AND MOISTURE-TEST WEIGHTS.

Nominal value	Tolerance
Grams	*Milligrams*
9 and 10	10
18	20

LIQUID-MEASURING DEVICES

GENERAL CODE REFERENCES.—Liquid-measuring devices shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.2., G–S.5.3.1., G–S.5.3.2., G–S.5.3.3., and G–S.6. See also general regulations G–R.1., G–R.2., G–R.3., G–R.4., and G–R.5.

A. APPLICATION.

A.1.—This code applies to devices for the measurement and delivery of liquids, including liquid fuels and lubricants, but does not apply to water meters, to devices used for dispensing liquefied petroleum gases or other liquids that do not remain in a liquid state at atmospheric pressures and temperatures, or to devices used solely for dispensing a product in connection with operations in which the amount of product dispensed does not affect customer charges.

D. DEFINITIONS.

D.1. LIQUID-MEASURING DEVICE.—A mechanism or machine designed to measure and deliver liquid by definite volume. Means may or may not be provided to indicate automatically, for one of a series of unit prices, the total money value of the liquid measured, or to make deliveries corresponding to specific money values at a definite unit price.

D.2. RETAIL DEVICE.—A device designed for single deliveries of less than 100 gallons and, in addition, any device designed or used for retail deliveries of motor fuels to individual highway vehicles.

D.3. WHOLESALE DEVICE.—Any device other than a retail device.

D.4. LIQUID-FUEL DEVICE.—A device designed for the measurement and delivery of liquid fuels, including motor fuels. ("Liquid fuels" includes all liquids used for fuel purposes.)

D.5. MOTOR-FUEL DEVICE.—A device designed for the measurement and delivery of liquids used as fuel for internal-combustion engines.

D.6. LUBRICANT DEVICE.—A device designed for the measurement and delivery of liquid lubricants, including, but not limited to, heavy gear lubricants and automatic-transmission fluids (automotive).

D.7. WET-HOSE TYPE.—A type of device designed to be operated with the discharge hose full of liquid at all times. A "wet hose" is the discharge hose on this type of device.

D.8. DRY-HOSE TYPE.—A type of device in which it is intended that the discharge hose be completely drained following the mechanical operations involved in each delivery. A "dry hose" is the discharge hose on this type of device.

D.9. PRESSURE TYPE.—A type of device designed for operation with the liquid under pressure artificially produced.

D.10. GRAVITY TYPE.—A type of device designed for discharge by gravity.

D.11. VISIBLE TYPE.—A type of device in which the measurement takes place in a visible glass measuring chamber.

D.12. ELAPSED-TIME TEST.—One to determine the leakage error that results solely from nonuse of a liquid-measuring device.

D.13. LEAKAGE ERROR.—On an elapsed-time test of a liquid-measuring device, the difference between the error on a normal delivery of a given nominal amount and the temperature-corrected (see N.1.4.) error on a delivery of the same nominal amount made after the device has stood unused.

S. SPECIFICATIONS.

SPECIFICATIONS APPLICABLE TO BOTH RETAIL AND WHOLESALE DEVICES

S.1. UNITS.—A liquid-measuring device shall indicate its deliveries in terms of gallons, quarts, pints, or binary-submultiple or decimal subdivisions of the gallon, except in the case of coin-operated devices. (See G–D.28.)

S.2. DESIGN.

S.2.1. LEVEL.—A device that is designed not to be manually portable in use shall be in normal operating position when it is in level.

S.2.2. STOP MECHANISM.—If stops or other stroke-limiting elements are subject to direct pressure or impact, the security of their positions shall be accomplished by positive, nonfrictional engagement of parts, and they shall be adjustable to provide for deliveries within prescribed tolerances. If two or more stops or other elements may selectively be brought into operation to permit deliveries of predetermined amounts, the position for the proper setting of each such element shall be accurately defined, inadvertent displacement from position shall be obstructed, and the delivery for which the device is set at any time shall be conspicuously indicated.

S.2.3. DISCHARGE HOSE.—This shall be adequately reinforced. A dry hose shall be of such length and stiffness as to facilitate its drainage; the inlet end of such hose or of an equivalent outlet pipe shall be at such a height as to permit proper drainage of the hose or pipe; there shall be an automatic vacuum breaker or equivalent means to prevent siphoning and to insure the complete and rapid drainage of the hose or pipe.

S.2.4. COMPLETENESS OF DELIVERY.—Valves intended to prevent reversal of flow shall be automatic in operation. On a liquid-fuel device, (1) if two or more delivery outlets are provided, delivery through one outlet shall not affect a subsequent delivery through any other outlet, and (2) if there is any possibility of diversion of measured liquid from a delivery outlet apparently in sole use and from which liquid is actually flowing, automatic means shall be provided by which any such diversion actually taking place will become obvious to an observer. On a lubricant device, there shall be no means by which diversion of measured lubricant can be made from the measuring chamber or discharge line during operation of the device.

S.2.5. DISCHARGE-LINE VALVES.—A discharge valve may be provided at the discharge end of the hose or elsewhere in the hose line only if the device is of the wet-hose type. If the discharge valve is so positioned, any other shut-off valve in any portion of the discharge line leading to this outlet shall be of the automatic or semiautomatic set-stop, or predetermining type, or shall be operable only (a) by means such as a wrench or screw driver (but not a pin) entirely separate from the device, or (b) by mutilation of a lead-and-wire seal by which the valve is sealed open. In a wet-hose, pressure-type device, an effective anti-drain valve shall be incorporated in the discharge valve or shall be installed immediately adjacent thereto. (See also S.10.3.)

S.2.6. AIR ELIMINATION.—A meter device or metering system shall be equipped with an effective air eliminator or other effective means to prevent passage of air or vapor through the meter.

S.2.7. EXHAUSTION OF SUPPLY.—On a lubricant device other than one of the meter type, means shall be provided for making the device inoperable or for giving a conspicuous and distinct warning when the level of the supply of lubricant becomes so low as to endanger the accuracy of measurement.

S.3. INDICATING ELEMENTS. (See also S.11.1., S.11.2., and S.21.1.)

S.3.1. READABILITY.—Quantity and money-value indications shall be readable from any reasonable customer position.

S.3.2. DIALS AND SCALES.—Dials and graduated scales intended to remain stationary under normal operating conditions shall be permanently fixed in position. Two or more scales used in combination with a single indicator shall read in the same direction.

S.3.3. ADVANCEMENT AND RETURN TO ZERO.—Indicating elements shall be susceptible of advancement only by the mechanical operation of the device. If a device is so designed that the indicating elements are readily returnable to a zero indication, means shall be provided to prevent the return of these elements beyond their correct zero position. However, a device may be cleared by advancing the indicating elements to zero, but only if the movement, once started, cannot be interrupted, or if the indications are automatically obscured until the elements reach zero position.

S.3.4. PARALLAX.—If quantities delivered by a liquid-fuel device are determined by bringing the surface of the liquid in a glass measuring chamber into coincidence with indicators or graduations, such indicators or graduations shall be inside the measuring chamber and not more than $\frac{1}{16}$ inch from its surface.

S.3.5. GRADUATIONS.—Graduations shall be not wider than 0.04 inch. Figures defining the values of graduations shall be in regular sequence.

S.3.6. UNIT-PRICE INDICATION.—In a device of the computing type or the coin-operated type, automatic means shall be provided for displaying on each face of the device the unit price at which the device is set to compute or to deliver at any time.

S.4. PROVISION FOR SEALING.—Provision shall be made for applying lead-and-wire seals in such manner that no adjustable measuring or quantity-indicating element (except such as alters deliveries corresponding to specific money values) and no adjustable element for controlling the delivery rate of a meter when such rate tends to affect the accuracy of deliveries, can be adjusted without mutilating the seal or seals.

S.5. MARKING.

S.5.1. AIR PRESSURES.—If a device is operable by air pressure the air-pressure gage shall show, by special graduations or otherwise, the maximum and minimum working pressures recommended by the manufacturer.

S.5.2. LIMITATION OF USE.—If a device is intended to measure accurately only products having particular properties, its limitations shall be clearly and permanently stated on the device unless these are reasonably obvious from the design or appearance of the device.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO RETAIL DEVICES

S.10. DESIGN.

S.10.1. SENSITIVENESS.—A retail device shall be readily operable to deliver accurately each quantity that the device holds itself forth to deliver. On a lubricant device, if the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 pint shall be not less than 1 inch.

S.10.2. INITIAL OPERATING CONDITION.—A retail liquid-fuel device shall be constructed to show whether or not the system is properly filled with liquid before a delivery is begun. However, a manually-operated shut-off valve may be installed in the stand pipe of a piston-type device, and a check valve may be installed in the discharge line of any device equipped with an effective mechanical air eliminator or equivalent means.

S.10.3. ZERO-SET-BACK INTERLOCK.—Effective July 1, 1957, *a retail motor-fuel device of the meter type shall be so constructed that, after a particular delivery cycle has been completed by movement of the starting lever to its shut-off position, an effective automatic interlock will prevent a subsequent delivery being started until the indicating elements have been returned to their correct zero positions.*

S.11. INDICATING ELEMENTS. (See also S.3.)

S.11.1. INDICATION OF DELIVERY.—A retail liquid-fuel device shall be constructed to show automatically its initial zero condition and the amounts delivered up to the nominal capacity of the device. If the nominal capacity is less than 50 gallons, this shall be conspicuously shown on each face of the device.

S.11.2. RETURN TO ZERO.—The primary indicating elements shall be readily returnable to a definite zero indication. (See also S.3.3.)

S.11.3. VISIBILITY.—The bottom of the lowest indicating element of a retail motor-fuel device shall be at least 36 inches above the normal level upon which the receiving vehicle or vessel stands. The indications of a retail motor-fuel device shall be readable from any position within a field of 120°, defined by two vertical planes each passing through the center of the face of the device at an angle of 30°.

S.12. MONEY-VALUE COMPUTATIONS.—Money-value computations on a retail device shall be of the full-computing type in which the money value, at one or at each of a series of unit prices, shall be computed for every delivery within the range of measurement of the device. Value graduations shall be supplied and shall be accurately positioned. The value of each graduated interval shall be 1 cent. However, the requirement of this specification for money-value computation for every delivery within the range of measurement of the device shall apply only up to the greatest money value that can be indicated by the computing elements.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO WHOLESALE DEVICES

S.20. DESIGN.

S.20.1. SENSITIVENESS.—A wholesale device shall be readily operable to deliver accurately any quantity from 50 gallons to the capacity of the device. If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 gallon shall be not less than 0.20 inch.

S.21. INDICATING ELEMENTS. (See also S.3.)

S.21.1. MINIMUM DELIVERY INDICATION.—The value of the smallest unit of indicated delivery on a wholesale device shall not exceed 1 gallon.

S.22. MARKING.

S.22.1. DISCHARGE RATES.—A wholesale meter shall be marked to show its designed maximum and minimum discharge rates. However, such minimum discharge rate shall not exceed 20 percent of such maximum discharge rate.

NOTES, PERFORMANCE REQUIREMENTS, AND REGULATIONS APPLICABLE TO BOTH RETAIL AND WHOLESALE DEVICES

N. NOTES.

N.1. TESTING PROCEDURES.

N.1.1. TESTING DRAFTS.—The full capacity delivery and each intermediate delivery for which the device is designed shall be tested in the case of retail piston-type and visible-type devices; for other types of retail devices used for dispensing motor fuel, testing drafts of one or more amounts, including drafts of at least 5 gallons, shall be utilized; for lubricant devices, testing drafts of two or more amounts, including drafts of 1 quart and of 4 or 6 quarts, shall be utilized. For wholesale devices, testing drafts should be equal to at least the amount delivered by the device in one minute at its maximum discharge rate, and shall in no case be less than 50 gallons.

N.1.2. NORMAL TESTS.—The "normal" test of a meter or meter-type device shall be made at the maximum discharge rate developed under the conditions of installation.

N.1.3. SPECIAL TESTS.—"Special" tests, to develop the operating characteristics of meters and meter-type devices, shall be made as circumstances require. A retail motor-fuel device shall be so tested at a minimum discharge rate of (a) 5 gallons per minute or (b) the minimum discharge rate marked on the device, whichever is less. A retail device other than a motor-fuel device shall be so tested at a minimum discharge rate of (a) 50 percent of the maximum discharge rate developed under the conditions of installation or (b) the minimum discharge rate marked on the device, whichever is less. A wholesale device shall be so tested at a minimum discharge rate of (a) 15 gallons per minute for a device with a rated maximum discharge less than 50 gallons per minute, (b) 20 percent of the marked maximum discharge rate for a device with a rated maximum discharge of 50 gallons per minute or more, or (c) the minimum discharge rate marked on the device, whichever is less.

N.1.4. TEMPERATURE CORRECTION.—In an elapsed-time test, the observed error on the delivery made after the device has stood unused shall be "corrected", if necessary, by allowing for the unavoidable volume change of the liquid in the device resulting from changes in temperature occurring during the period of nonuse of the device. In the case of motor fuels this temperature-volume change may be computed at 0.6 percent per 10° F, and 1.1 percent per 10° C, change of temperature.

P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. OPERATING CONDITIONS.—The deliveries of a device shall be accurate (a) irrespective of whether operation is continuous or intermittent, (b) irrespective of the speed of operation, subject, however, to the provisions of T.1., and (c) irrespective of the time elapsing between operations, subject, however, to the provisions of T.2. However, if a lubricant device is operable by air pressure and is tested at an operating pressure below the minimum pressure recommended by the manufacturer, only the tolerance on overregistration shall be applied, and errors of underregistration shall be disregarded.

T. TOLERANCES. (See also G–T. 5. andG–T. 6.)

T.1. ON "NORMAL" TESTS AND "SPECIAL" TESTS EXCEPT ELAPSED-TIME TESTS.—Maintenance tolerances for liquid-measuring devices, on "normal" tests and on "special" tests except elapsed-time tests, on underregistration and on overregistration shall be as shown in table 1. Acceptance tolerances for retail devices and on "normal" tests of wholesale devices shall be one-half the maintenance tolerances. Acceptance tolerances on "special" tests of wholesale devices shall be the same as the maintenance tolerances on such tests. (See N.1.2. and N.1.3.) (The error of a liquid-measuring device—to which the tolerance is applied—is the difference between the indication of the device and the amount of liquid actually delivered by the device.)

TABLE 1.—MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR LIQUID-MEASURING DEVICES, EXCEPT ON ELAPSED-TIME TESTS

For retail devices	
Indication	**Tolerance**
Gallons	*Cubic inches*
½ or less	2
1	3
2	4
3	5
4	6
5	7
Over 5	Add 1 cubic inch per indicated gallon.

For wholesale devices		
Indication	**Tolerance**	
	On "normal" tests	**On "special" tests**
Gallons	*Cubic inches*	*Cubic inches*
50	50	50
Over 50	Add ½ cubic inch per indicated gallon.	Add 1 cubic inch per indicated gallon.

T.2. ON ELAPSED-TIME TESTS.—Maintenance tolerances on elapsed-time tests of liquid-measuring devices shall be 2 cubic inches per hour for a retail device and 5 cubic inches per hour for a wholesale device. Acceptance tolerances shall be one-half the maintenance tolerances. (The error to which these tolerances are applied is the leakage error (D.13.). See also N.1.4.)

R. REGULATIONS.

R.1. INSTALLATION.

R.1.1. PLUMB AND LEVEL CONDITION.—A device installed in a fixed location shall be installed plumb and level and the installation shall be sufficiently strong and rigid to maintain this condition.

R.1.2. SUCTION HEAD.—A piston-type device shall be so installed that the total effective suction head will not be great enough to cause vaporization of the liquid being dispensed, under the highest temperature and lowest barometric pressure likely to occur.

R.1.3. DISCHARGE RATE.—A wholesale device shall be so installed that the actual maximum discharge rate will not exceed the rated maximum discharge rate; if necessary, means for flow regulation shall be incorporated in the installation, in which case this shall be fully effective and automatic in operation.

R.2. LENGTH OF DISCHARGE HOSE.—The length of the discharge hose on a retail motor-fuel device shall not exceed 15 feet, measured from the outside of the housing of the device to the inlet end of the discharge nozzle, unless it can be demonstrated that a longer hose is essential to permit deliveries to be made to receiving vehicles or vessels. Unnecessarily remote location of a device shall not be accepted as justification for an abnormally long hose.

R.3. RETURN OF INDICATING ELEMENT TO ZERO.—On any device used in making retail deliveries to individual consumers, the primary indicating elements shall be returned to zero before each such delivery.

R.4. IDENTIFICATION OF RESPONSIBLE PARTY.—A coin-operated retail device shall be legibly and permanently marked to show the name and address of the person, firm, or corporation to whom application may be made for adjustment of any claim arising from failure of the device to deliver accurately.

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VEHICLE TANKS

GENERAL CODE REFERENCES.—Vehicle tanks shall conform to all of the applicable requirements of the General Code, particularly G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.2., G–S.5.3.1., G–S.5.3.2., G–S.5.3.3., G–S.6., G–T.5., and G–T.6. See also general regulations G–R.2., G–R.3., G–R.4., and G–R.5.

D. DEFINITIONS.

D.1. VEHICLE TANK.—An assembly used for the delivery of liquids, comprising a tank, which may or may not be subdivided into two or more compartments, mounted upon a vehicle, together with its accessory piping, valves, meters, etc.

D.2. COMPARTMENT.—The entire tank when this is not subdivided; otherwise, any one of those subdivisions of a tank designed to hold liquid.

S. SPECIFICATIONS.

SPECIFICATIONS APPLICABLE BOTH TO VEHICLE TANKS USED AS MEASURES AND TO VEHICLE TANKS EQUIPPED WITH METERS

S.1. STRENGTH.—The shell and bulkheads of a vehicle tank shall be so constructed that under any condition of liquid lading they will not become distorted sufficiently to cause a change in the capacity of any compartment equal to more than ½ pint per 200 gallons, or fraction thereof, of the nominal compartment capacity, or to more than 1 pint, whichever is greater.

S.2. VENTING.—Effective venting means shall be provided to prevent the formation of air pockets in a compartment by permitting the escape of air from all parts of the compartment designed to be filled with liquid, and to permit the influx of air to a compartment during discharge therefrom.

S.3. DOME FLANGE AND BAFFLE PLATES.—Any dome flange extending into a compartment shall be provided with sufficient perforations or openings flush with the compartment shell to prevent any trapping of air. All baffle plates in a compartment shall be so cut away at top and bottom, and elsewhere as necessary, as to facilitate loading and unloading.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO VEHICLE TANKS USED AS MEASURES

S.10. DESIGN.

S.10.1 FILL OR INSPECTION OPENING.—The fill or inspection opening of a compartment shall be of such size and location that it can readily be determined by visual inspection that the compartment has been properly filled or completely emptied, *and shall be so positioned with respect to the ends of the compartment that the indicator may be positioned as required by S.*10.3. *In no case shall the opening, if circular, have a diameter of less than 7⅞ inches, or, if other than circular, have an effective area of less than 45 square inches.*

S.10.2. COMPARTMENT AND PIPING CAPACITIES AND EMERGENCY VALVE.—If a compartment is equipped with an emergency (or safety) valve, this shall be positioned at the lowest point of outlet from the compartment, and the compartment capacity or capacities shall be construed as excluding the capacity of the piping leading therefrom. However, the capacity of the piping leading from such a compartment shall be separately determined and reported, and may be separately marked as specified in S.11.2.

S.10.3. COMPARTMENT INDICATORS.

S.10.3.1. NUMBER.

S.10.3.1.1. SINGLE INDICATOR.—Except in the special case covered by S.10.3.1.2., a compartment shall be provided with only one indicator.

S.10.3.1.2. MULTIPLE INDICATORS.—Two or three, but not more than three, indicators shall be permitted in a compartment when such multiple indicators are necessary to comply with highway-load-limit requirements.

S.10.3.2. POSITION.—An indicator shall be positioned as nearly as practicable (1) *midway between the sides of its compartment* and (2) midway between the ends of its compartment; *it shall be adjacent to but shall not extend into that section of the compartment defined by a vertical projection of the fill opening. In no case shall an indicator be offset from a position midway between the ends of the compartment by more than 10 percent of the compartment length.*

S.10.3.3. DESIGN.—An indicator shall be so designed that it will distinctly and unmistakably define a capacity point of its compartment when liquid is in contact with the lowest portion of the indicator.

S.10.3.4. SECURITY OF POSITION.—Any indicator not intended to remain adjustable shall be securely welded in position. Adequate provision shall be made for affixing a lead-and-wire seal or seals to any indicator intended to remain adjustable, and to any removable part to which an indicator may be attached, so that no adjustment of the indicator can be made and so that the said part cannot be removed without destroying or mutilating the seal or seals.

S.10.3.5. IDENTIFICATION.—If a compartment is provided with multiple indicators, each such indicator shall be conspicuously marked with an identifying letter or number.

S.10.4. SENSITIVENESS.—The position of any indicator in its compartment shall be such that at the level of the indicator a change of 0.04 inch in the height of the liquid surface will represent a volume change of not more than the value of the tolerance for the nominal compartment capacity as defined by that indicator.

S.10.5. EXPANSION SPACE.—When a compartment is filled to the level of the highest indicator in the compartment, there shall remain an expansion space of at least 0.75 percent of the nominal compartment capacity as defined by that indicator.

S.10.6. COMPLETENESS OF DELIVERY.—A tank shall be so constructed that, when it is standing on a level surface, complete delivery can be made from any compartment through its delivery faucet or valve whether other compartments are full or empty.

S.10.7. MANIFOLD.—*When two or more compartments discharge through a common manifold or other single outlet, effective and automatic means shall be provided to insure (1) that liquid can flow through the delivery line leading from only one compartment at one time and can not flow from one compartment into another compartment or (2) that all compartments will discharge simultaneously. If the discharge valves from two or more compartments are automatically so controlled that they can only be operated together, thus effectively connecting these compartments each to the other, such compartments shall, for purposes of this paragraph, be construed to be one compartment.*

S. 11. MARKING.

S.11.1. COMPARTMENT IDENTIFICATION.—Each compartment of a multiple-compartment tank shall be conspicuously identified *by a letter or number marked on the dome or immediately below the fill opening. Such letters or numbers shall be in regular sequence from front to rear, and the delivery faucets or valves shall be marked to correspond with their respective compartments.*

S.11.2. COMPARTMENT CAPACITIES.—A compartment provided with a single indicator shall be marked with a statement of its capacity as defined by its indicator. A compartment provided with multiple indicators shall be marked with a statement identifying each such indicator by its letter or number (as required by S.10.3.5.) and giving the corresponding capacity. Capacity statements shall be positioned immediately adjacent to the identifying letter or number of the compartment. (In addition to the capacity marking required by this paragraph, any compartment indicator may be marked to show the gallonage it defines.)

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO VEHICLE TANKS EQUIPPED WITH METERS

S. 20. DESIGN.

S.20.1. AIR ELIMINATION.—An effective air eliminator or other effective means to prevent passage of air or vapor through the meter shall be provided.

S.20.2. DIVERSION OF MEASURED LIQUID.—No means shall be provided by which any measured liquid can be diverted from the measuring chamber of the meter or the discharge line therefrom. However, two or more delivery outlets may be installed if automatic means is provided to insure that (a) liquid can flow from only one such outlet at one time and (b) the direction of flow for which the mechanism may be set at any time is definitely and conspicuously indicated.

S.20.3. DELIVERY HOSE.—On a gravity-discharge unit, the delivery hose shall be as short as practicable, and there shall not be a shut-off valve at its outlet end. On a pump-discharge unit, the delivery hose shall be of the wet-hose type with a shut-off valve at its outlet end, and immediately adjacent to this valve there shall be a spring-loaded check valve so adjusted that drainage of the hose will automatically be prevented; however, this requirement shall not apply to special, properly constructed delivery facilities used for the fueling of large aircraft.

S.20.4. MANIFOLD.—*On a pump-discharge unit, when two or more compartments discharge through a common manifold or other single outlet, effective and automatic means shall be provided to insure that liquid can flow through the delivery line leading from only one compartment at one time and can not flow from one compartment into another compartment.*

S.21. METER.

S.21.1. INDICATIONG ELEMENTS.

S.21.1.1. TERMS OF INDICATION.—Meters shall indicate in terms of gallons, and the value of the smallest unit of indicated delivery shall not exceed 1 gallon except on a meter used for retail deliveries of liquid fuel for domestic use, in which case the value of the smallest unit of indicated delivery shall not exceed 1 pint. Fractional parts of the gallon may be indicated in terms of either decimal or binary submultiple subdivisions.

S.21.1.2. TRAVEL OF INDICATOR.—If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a delivery of 1 gallon shall be not less than 0.20 inch.

S.21.1.3. WIDTH OF GRADUATIONS.—Graduations shall be not wider than 0.04 inch.

S.21.1.4. MOVEMENT AND RETURN TO ZERO.—Primary indicating elements may be advanced only by the mechanical operation of the meter, they shall be readily returnable to a definite zero indication, and means shall be provided to prevent the return of these elements beyond their correct zero position. However, a meter may be cleared by advancing the indicating elements to zero, but only if the movement, once started, cannot be interrupted, or if the indications are automatically obscured until the elements reach zero position.

S.21.2. PROVISION FOR SEALING.—Adequate provision shall be made for affixing a lead-and-wire seal or seals in such manner that no adjustment of any measuring or primary indicating element can be made without destroying or mutilating the seal or seals.

S.21.3. MARKING.

S.21.3.1. RATES AND WORKING PRESSURE.—A meter shall be marked to show the maximum and minimum discharge rates and the maximum working pressure recommended by the manufacturer.

S.21.3.2. LIMITATION OF USE.—If a meter is intended to measure accurately only liquids having particular properties, it shall be marked to show its limitations.

NOTES, PERFORMANCE REQUIREMENTS, AND REGULATIONS APPLICABLE BOTH TO VEHICLE TANKS USED AS MEASURES AND TO VEHICLE TANKS EQUIPPED WITH METERS

N. NOTES.

N.1. TESTING MEDIUM.

N.1.1. FOR COMPARTMENT TESTING.—Water or light fuel oil shall be used as the testing medium in determining the capacity of a vehicle-tank compartment.

N.1.2. FOR METER TESTING.—A vehicle-tank meter shall be tested with liquid of the same character, or of approximately the same viscosity, as the liquid to be commercially measured.

N.2. TESTING PROCEDURES.

N.2.1. DISCHARGE RATES FOR METERS.—The "normal" test of a meter shall be made at the maximum rate permitted by the installation. "Special" tests, to develop the operating characteristics of a meter and the operating elements associated therewith, shall be made as circumstances require; a meter smaller than 2 inches in rated size shall be so tested at a minimum discharge rate of (a) 15 gallons per minute or (b) the minimum rate marked on the meter, whichever is less; and a meter 2 inches or over in rated size shall be so tested at a minimum discharge rate of (a) 20 percent of the marked maximum rate or (b) the minimum rate marked on the meter, whichever is less.

N.2.2. TESTING DRAFTS FOR METERS.—Testing drafts should be equal to at least the amount delivered by the meter in one minute at its maximum discharge rate, and shall in no case be less than 50 gallons.

N.2.3. EVAPORATION AND VOLUME CHANGE OF TEST LIQUID.—Care shall be exercised to reduce to a minimum evaporation losses, and volume changes resulting from changes in temperature, of the test liquid.

N.2.4. ADJUSTMENT AND REMARKING.—When a compartment is found, upon test, to have an error in excess of the applicable tolerance, the capacity of the compartment shall be adjusted to agree with its marked capacity, or its marked capacity shall be changed to agree with its capacity as determined by the test.

N.3. GAGING OF COMPARTMENTS.—When a compartment is gaged to determine the proper position for an indicator or to determine what a capacity marking should be, whether on a new vehicle tank or following repairs or modifications that might affect compartment capacities, tolerances are not applicable, and the indicator shall be set and the compartment capacity shall be marked as accurately as practicable.

P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. OPERATING CONDITIONS FOR METERS.—The delivery of a meter shall be accurate (a) irrespective of whether its operation is continuous or intermittent, and (b) when operated as specified in N.2.1., subject, however, to the provisions of T.2.

T. TOLERANCES.

T.1. ON VEHICLE-TANK COMPARTMENTS.—Maintenance and acceptance tolerances in excess and in deficiency for vehicle-tank compartments used as measures shall be as shown in table 1. (The error of a compartment—to which the tolerance is applied—is the difference between the marked capacity of the compartment and the compartment capacity as determined by test.)

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR VEHICLE-TANK COMPARTMENTS USED AS MEASURES

Nominal compartment capacity	Tolerance
Gallons	*Quarts*
200 or less	2
201 to 400, incl	3
401 to 600, incl	4
601 to 800, incl	5
801 to 1,000, incl	6
Over 1,000	Add 1 quart per 200 gallons or fraction thereof.

T.2. ON VEHICLE-TANK METERS.—Maintenance tolerances, on underregistration and on overregistration, for vehicle-tank meters shall be as shown in table 2. Acceptance tolerances on "normal" tests shall be one-half the maintenance tolerances. Acceptance tolerances on "special" tests (see N.2.1.) shall be the same as the maintenance tolerances on such tests. (See also G–T.5. and G–T.6.)

TABLE 2.—MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR VEHICLE-TANK METERS

Indication	Tolerance	
	On "normal" tests	On "special" tests
Gallons	*Cubic inches*	*Cubic inches*
50	50	50
Over 50	Add 1/2 cubic inch per indicated gallon.	Add 1 cubic inch per indicated gallon.

R. REGULATIONS.

R.1. REINSPECTION.—Whenever a tank is damaged, repaired, or modified in any way that might affect the accuracy of measurement of its deliveries, it shall not thereafter be used for measurement until it has been officially inspected and reapproved.

R.2. CONDITIONS OF USE.—When a tank is used as a measure, the vehicle shall stand upon a level surface during the filling of the compartments. During a delivery the vehicle shall be so positioned as to insure complete delivery whenever the delivery is such that a compartment should be completely emptied.

FARM MILK TANKS

GENERAL CODE REFERENCES.—Farm milk tanks shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.3.1., G–S.5.3.2., G–S.5.3.3., G–S.5.4., and G–S.6. See also general regulations G–R.2., G–R.3., and G–R.5.

A. APPLICATION.

A.1.—This code applies to farm milk tanks, as defined, only when these are used, or are to be used, under an express contract between the producer and the purchaser and only on the premises of a single producer, for the commercial measurement of milk or other fluid dairy products. This code does not apply to tanks mounted on highway vehicles. If measurement is accomplished by means of a fluid meter, this code does not apply; in such case the meter shall be subject to the applicable provisions of the code for liquid-measuring devices.

D. DEFINITIONS.

D.1. FARM MILK TANK.—A unit for measuring milk or other fluid dairy product, comprising a combination of (1) a stationary or portable tank, whether or not equipped with means for cooling its contents, (2) means for reading the level of liquid in the tank, such as a removable gage rod or a surface gage, and (3) a chart for converting level-of-liquid readings to gallons; or such a unit in which readings are made on gage rod or surface gage directly in terms of gallons. Each compartment of a subdivided tank shall, for purposes of this code, be construed to be a "farm milk tank".

D.2. CENTER-READING TANK.—One so designed that the gage rod or surface gage, when properly positioned for use, will be approximately in the vertical axis of the tank, centrally positioned with respect to the tank walls.

D.3. GAGE ROD.—A graduated, "dip-stick" type of measuring rod designed to be partially immersed in the liquid and to be read at the point where the liquid surface crosses the rod.

D.4. SURFACE GAGE.—A combination of (1) a stationary indicator and (2) a movable, graduated element designed to be brought into contact with the surface of the liquid from above.

S. SPECIFICATIONS.

S.1. DESIGN. (See also S.3.)

S.1.1. LEVEL.—A farm milk tank shall be designed to be in normal operating position when it is in level. The tank shall be so constructed that it will maintain its condition of level under all normal conditions of lading.

S.1.2. GAGE-ROD BRACKET OR SUPPORTS.—If a tank is designed for use with a gage rod, a substantial and rigid gage-rod bracket or other suitable supporting elements for positioning the gage rod shall be provided. A gage rod and its bracket or other supporting elements shall be so constructed that whenever the rod is placed in engagement with the bracket or supports and released, the rod will automatically seat itself at a fixed height and in a vertical position. When a gage rod is properly seated on its bracket or supports, there shall be a clearance of at least 3 inches between the graduated face of the rod and any tank wall or other surface that it faces.

S.1.3. SURFACE GAGE BRACKET OR SUPPORTS.—If a tank is designed for use with a surface gage, a substantial and rigid surface-gage bracket or other suitable supporting elements for positioning the surface gage shall be provided. A surface gage and its bracket or other supporting elements shall be so constructed that whenever the gage assembly is placed in engagement with the bracket or supports, the indicator, if not permanently mounted on the tank, will automatically seat itself in correct operating position, and the graduated element will be vertically positioned and will be securely held at any height to which it may be manually set.

S.1.4. PORTABLE TANK.—A portable tank shall be of the center-reading type.

S.2. INDICATING MEANS.

S.2.1. GAGE ROD.—When properly seated in position, a rod shall not touch the bottom of the tank unless this is required by the design of the supporting elements. The rod shall be graduated throughout an interval corresponding to the gallonage range within which readings of liquid level are to be made. *The graduated face of the rod shall have a dull finish.*

S.2.2. SURFACE GAGE.—When properly engaged with its bracket and set to its lowest position, a surface gage shall not touch the bottom of the tank. The gage shall be graduated throughout an interval corresponding to the gallonage range within which readings of liquid level are to be made.

S.2.3. SPACING AND WIDTH OF GRADUATIONS.—On a gage rod or surface gage, the spacing of the graduations, center to center, shall be not more than 0.0625 ($\frac{1}{16}$) inch and not less than 0.03125 ($\frac{1}{32}$) inch; the graduations shall be not less than 0.005 inch in width, and the clear interval between adjacent edges of successive graduations shall be not less than 0.015625 ($\frac{1}{64}$) inch. The requirement of general specification G–S.5.1.3. relative to minimum width of graduations, and the requirements of general specification G–S.5.2., shall not apply to gage rods and surface gages.

S.2.4. VALUES OF GRADUATIONS.—On a gage rod or surface gage, the graduations may be designated in inches and fractions thereof, or may be identified in a numerical series without reference to inches or fractions thereof. In either of these cases there shall be provided for each such rod or gage and each tank with which it is associated, a gallonage chart showing values in terms of gallons of liquid in the tank, corresponding to each graduation on the rod or gage. If a rod or gage is associated with but one tank, in lieu of linear or numerical-series graduations and gallonage chart, values in terms of gallons of liquid in the tank may be shown directly on the rod or gage.

S.3. SENSITIVENESS.—The value of a graduated interval on a gage rod or surface gage (exclusive of the interval from the bottom of the tank to the lowest graduation) shall not exceed 1 gallon for a tank of a nominal capacity of 500 gallons or less, and shall not exceed 2 gallons for a tank of a nominal capacity of more than 500 gallons.

S.4. GALLONAGE CHART.—A gallonage chart shall show gallonage values only, and shall show such values at least to the nearest ½ gallon for a tank of a nominal capacity of 500 gallons or less, and at least to the nearest 1 gallon for a tank of a nominal capacity of more than 500 gallons. All letters and figures on the chart shall be distinct and easily readable, the chart shall be substantially constructed, and the face of the chart shall be so protected that its lettering and figures will not tend easily to become obliterated or illegible.

S.5. LEVEL-INDICATING MEANS.—A tank shall be equipped with sensitive means by which the level of the tank can be determined. On a stationary tank such means shall be a two-way or circular level, a plumb bob, two-way leveling lugs, or the like; or the top edge or edges of the tank shall be so constructed throughout as to provide an accurate reference for level determinations. On a portable tank such means shall be either a two-way or a circular level. *If a tank has a nominal capacity greater than 500 gallons, two level-indicating means shall be provided, in opposite positions on the tank.* On a portable tank, the level indicating means, or one such means if two are provided, shall be readable by an observer from the position normally occupied when manipulating the gage rod or surface gage. A level, leveling lugs, or the support and reference index for a plumb bob shall be permanently attached to the tank.

S.6. INSTALLATION.—A stationary tank shall be rigidly installed in level without the use of removable blocks or shims under the legs; if such tank is not mounted permanently in position, the correct position on the floor for each leg shall be clearly and permanently defined.

S.7. IDENTIFICATION.—A tank and any gage rod or surface gage and gallonage chart associated therewith shall be mutually identified, as by a common serial number, in a prominent and permanent manner.

N. NOTES.

N.1. GAGING AND TESTING.—Tanks shall be originally gaged and officially tested "to deliver." (If a tank is gaged or tested by measuring test liquid into the tank, the inside tank walls shall first be thoroughly wetted and the tank shall be drained for 30 seconds after the main drainage flow has ceased.) A tank shall be in level, as shown by the level-indicating means required by S.5., during gaging and testing.

N.2. TESTING MEDIUM.—Water shall be used as the testing medium in gaging and testing tanks.

N.3. APPROVAL SEALS.—When a tank is officially tested and approved, the gage rod or surface gage, and the gallonage chart if a chart is utilized, as well as the tank itself, shall be suitably marked to indicate such approval.

N.4. PREPARATION OF GALLONAGE CHART.—When a tank is gaged for the purposes of preparing a gallonage chart, tolerances are not applicable, and the chart shall be prepared as accurately as practicable.

P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. OPERATING CONDITIONS FOR PORTABLE TANKS.—The indications of a portable tank shall be accurate when the tank is out of level in any direction by any amount not exceeding 5 percent or approximately 3 degrees.

T. TOLERANCES.

T.1. MINIMUM TOLERANCE VALUES.—On a particular tank, the maintenance and acceptance tolerances applied shall be not smaller than the smallest volume corresponding to a graduated interval at any point on the gage rod or surface gage.

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T.2. BASIC TOLERANCE VALUES.—Basic maintenance and acceptance tolerances on underregistration and on overregistration shall be as shown in table 1. (The error, at any liquid level, of a tank—to which the tolerance is applied—is the difference between the gallonage shown for that level on the gallonage chart and the corresponding gallonage determined by test.)

TABLE 1.—BASIC MAINTENANCE AND ACCEPTANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR FARM MILK TANKS

Indicated gallonage	Tolerance
	Gallons
500 or less	1
501 to 1,000, incl	2
1,001 to 1,500, incl	3
1,501 to 2,000, incl	4
Over 2,000	5

R. REGULATIONS.

R.1. LEVEL CONDITION.—A stationary farm milk tank shall be maintained in level. On a portable tank, measurement readings shall be made only when the tank is approximately level—that is, when it is not out of level by more than 5 percent or approximately 3 degrees in any direction.

LIQUID MEASURES

GENERAL CODE REFERENCES.—Liquid measures shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., and G–S.6. See also general regulations G–R.2. and G–R.3.

A. APPLICATION.

A.1.—This code applies to liquid measures, as defined, except special varieties of liquid measures for which there are separate codes. It does not apply to test measures or other volumetric standards.

D. DEFINITIONS.

D.1. LIQUID MEASURE.—A rigid measure of capacity, designed for general and repeated use in the measurement of liquids.

S. SPECIFICATIONS.

S.1. UNITS.—The capacity of a liquid measure shall be 1 gill, ½ liquid pint, 1 liquid pint, 1 liquid quart, ¼ gallon, 1 gallon, 1¼ gallons, 1½ gallons, or a multiple of 1 gallon, and the measure shall not be subdivided.

S.2. MATERIAL.—Measures shall be made of metal, glass, earthenware, enameled ware, composition, or similar and suitable material. If made of metal, the thickness of the metal shall be not less than the appropriate value given in table 1.

TABLE 1.—MINIMUM THICKNESSES OF METAL FOR LIQUID MEASURES

Nominal capacity	Minimum thickness	
	For iron or steel, plated or unplated [a]	For copper or aluminum
	Inch	*Inch*
1 pint or less	0. 010	0. 020
1 quart, 1/2 gallon, 1 gallon	. 014	. 028
Over 1 gallon	. 016	. 032

[a] The following commercial tin plates comply with these requirements: For 1 pint or less ICL; for 1 quart, ½ gallon, and 1 gallon IX; for over 1 gallon 2XL.

S.3. DESIGN.

S.3.1. CAPACITY POINT.—The capacity of a measure shall be determined to a definite edge, or to the lowest portion of a plate, bar, or wire, at or near the top of the measure, and shall not include the capacity of any lip or rim that may be provided.

S.3.2. REINFORCING RINGS.—Reinforcing rings, if used, shall be attached to the outside of the measure and shall show no divisions or lines on the inside surface of the measure.

S.3.3. DISCHARGE.—A measure equipped with a discharge faucet or valve shall be susceptible of complete discharge through the faucet or valve when the measure is standing on a level surface.

S.4. MARKING.—A measure shall be marked on its side with a statement of its capacity; if the capacity is stated in terms of the pint or quart, the word "Liquid" or the abbreviation "Liq" shall be included.

N. NOTES.

N.1. ICE CREAM MOLDS AND CANS.—This code shall not be construed to prohibit 3-pint and 5-pint brick molds and 2½-gallon (10-quart) cans when used exclusively for ice cream.

T. TOLERANCES.

T.1.—Maintenance tolerances in excess and in deficiency shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 2.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR LIQUID MEASURES

Nominal capacity	Tolerance			
	In excess		In deficiency	
	Fluid drams	*Cubic inches*	*Fluid drams*	*Cubic inches*
1/2 pint or less	2	0.4	1.0	0.2
1 pint	3	.7	1.5	.3
1 quart	4	.9	2.0	.5
1/2 gallon	6	1.4	3.0	.7
	Fluid ounces			
1 and 1 1/4 gallons	1	1.8	4.0	.9
1 1/2 gallons	1.5	2.7	6.0	1.4
			Fluid ounces	
2 gallons	2	3.5	1	1.8
3 and 4 gallons	4	7.0	2	3.6
5 gallons	6	11.0	3	5.4
10 gallons	10	18.0	5	9.0

GRADUATES

GENERAL CODE REFERENCES.—Graduates shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.2., and G–S.6. See also general regulations G–R.2. and G–R.3.

D. DEFINITIONS.

D.1. GRADUATE.—A subdivided glass measure of capacity, either cylindrical or conical in shape, provided with a pouring lip and a base.

S. SPECIFICATIONS.

S.1. BASIS OF GRADUATION.—*A graduate shall be graduated "to deliver" when the temperature of the graduate is 20° C (68° F), and shall be marked accordingly in a permanent and conspicuous manner.*

S.2. MATERIAL.—A graduate shall be made of good-quality, thoroughly annealed, clear, transparent glass, free from bubbles and streaks that might affect the accuracy of measurement, and of uniform but not excessive thickness.

S.3. DESIGN.

S.3.1. TYPE.—A graduate of a capacity of more than 4 fluid drams (15 milliliters) may be of either the cylindrical or conical type. *A graduate of a capacity of 4 fluid drams (15 milliliters) or less shall be of the single-scale cylindrical type.*

S.3.2. PROPORTIONS.—The inside measurement from the bottom of the graduate to the capacity graduation shall be not less than five times the inside diameter on a cylindrical graduate, and two times the inside diameter at the capacity graduation on a conical graduate. On a conical graduate the inside measurement from the bottom of the graduate to the point representing one-fourth of the capacity shall be not less than the inside diameter at that point.

S.3.3. BASE.—The base shall be perpendicular to the axis of the graduate and of such diameter that the empty graduate will stand on a surface making an angle of 25 percent, or approximately 15°, with the horizontal.

S.3.4. GRADUATED INTERVALS.—*Effective July 1, 1956 a graduate shall have an initial interval that is not subdivided, equal to not less than one-fifth and not more than one-fourth of the capacity of the graduate. Except for this initial interval, the values of all graduated intervals shall be the same. Nominal capacities, graduation ranges, values of graduated intervals, and numbered graduations, applicable to single-scale graduates and to the appropriate portions of double-scale graduates, shall be as shown in table 1.*

TABLE 1.—DESIGN DETAILS FOR GRADUATES

Nominal capacity	To be graduated between—	Value of graduated intervals	To be numbered at each even—
Minims	*Minims*	*Minims*	*Minims*
60	15 and 60	5	[a]10
120	30 and 120	10	[b]20
Fluid drams	*Fluid drams*	*Fluid drams*	*Fluid drams*
4	1 and 4	1/2	1
8	2 and 8	1	2
Fluid ounces	*Fluid ounces*	*Fluid ounces*	*Fluid ounces*
2	1/2 and 2	1/4	1/2
4	1 and 4	1/2	1
8	2 and 8	1/2	1
16	4 and 16	1	2
32	8 and 32	2	4
Milliliters	*Milliliters*	*Milliliters*	*Milliliters*
5	1 and 5	1/2	1
10	2 and 10	1	2
25	5 and 25	5	5
50	10 and 50	5	10
100	20 and 100	10	20
250	50 and 250	25	50
500	100 and 500	25	50
1000	200 and 1000	50	100

[a] And, in addition, at the first, or 15-minim, graduation.
[b] And, in addition, at the first, or 30-minim, graduation.

S.4. GRADUATIONS.

S.4.1. GENERAL.—Graduations shall be perpendicular to the axis of the graduate and parallel to each other. Graduations shall be etched or engraved and shall be not wider than 0.015 inch (0.38 millimeter). No graduation shall extend less than one-fourth the distance around the graduate. *On a single-scale graduate, the main graduations shall completely encircle the graduate and subordinate graduations shall extend at least one-half the distance around the graduate.* On a double-scale, or duplex, graduate, there shall be a clear space between the ends of the main graduations on the two scales and this space shall be approximately 90° from the lip of the graduate and shall conform to the requirements of table 2.

TABLE 2.—CLEAR SPACE BETWEEN ENDS OF MAIN GRADUATIONS ON DOUBLE-SCALE GRADUATES

Inside diameter of graduate at the graduations	Clear space between ends of main graduations
Inches	*Inch*
Less than 1.5	1/8 to 1/4
1.5 to 3, incl	1/4 to 1/2
Over 3	3/8 to 5/8

S.4.2. MARKING.—Each main graduation shall be marked to show its value; intermediate graduations shall not be marked. Value figures shall be uniformly positioned either directly upon or immediately above the graduations to which they refer. Figures placed upon graduations shall be set in from the ends of the graduations a sufficient distance to allow the ends of the graduations to be used in making a setting. (See also S.1.)

T. TOLERANCES.

T.1.—Maintenance and acceptance tolerances in excess and in deficiency shall be as shown in table 3 for graduates that are graduated "to contain" or "to deliver". (The tolerance to be applied at any graduation is determined by the inside diameter of the graduate at the graduation in question.)

TABLE 3.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR GRADUATES

Inside diameter of graduate	Tolerance		Inside diameter of graduate	Tolerance
Inches	*Fluid drams*	*Minims*	*Millimeters*	*Milliliters*
1/2 or less	--	2	15 or less	0.1
9/16 to 3/4, incl	--	3	16 to 20, incl	.2
13/16 to 1, incl	--	6	21 to 25, incl	.4
			26 to 30, incl	.6
1 1/16 to 1 1/4, incl	--	10	31 to 35, incl	.8
1 5/16 to 1 1/2, incl	--	15		
1 9/16 to 1 3/4, incl	--	20	36 to 40, incl	1.1
1 13/16 to 2, incl	--	30	41 to 45, incl	1.4
			46 to 50, incl	1.8
2 1/16 to 2 1/4, incl	--	40	51 to 55, incl	2.2
2 5/16 to 2 1/2, incl	--	50	56 to 60, incl	2.8
2 9/16 to 2 3/4, incl	1	5		
2 13/16 to 3, incl	1	20	61 to 65, incl	3.4
			66 to 70, incl	4.1
3 1/16 to 3 1/4, incl	1	35	71 to 75, incl	4.8
3 5/16 to 3 1/2, incl	1	50	76 to 80, incl	5.6
3 9/16 to 3 3/4, incl	2	10	81 to 85, incl	6.4
3 13/16 to 4, incl	2	30		
			86 to 90, incl	7.2
			91 to 95, incl	8.1
			96 to 100, incl	9.0

MEASURE-CONTAINERS

GENERAL CODE REFERENCES.—Measure-containers shall conform to all the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., and G-S.6. See also general regulation G–R.3.

A. APPLICATION.

A.1.—This code applies to retail measure-containers and to pre-packaged-ice-cream measure-containers, as defined. It does not apply to containers used for milk, cream, or buttermilk, which are covered by the code for Milk Bottles, or to containers used for the factory prepacking of packages of commodities other than ice cream, sherbet, and similar frozen desserts.

D. DEFINITIONS.

D.1. RETAIL MEASURE-CONTAINER.—A container intended to be used once only, to determine at the time of retail sale the quantity of commodity comprising a retail sale made from bulk supply on the basis of liquid measure, and to serve as the container for the delivery of the commodity. Hereafter in this code a retail measure-container is referred to as a "retail container".

D.2. PREPACKAGED-ICE-CREAM MEASURE-CONTAINER.—A container intended to be used once only, to determine in advance of sale the quantity of ice cream, sherbet, or other similar frozen dessert, on the basis of liquid measure, comprising a wholesale or retail marketing unit, and to serve as the container for the delivery of the commodity. Hereafter in this code a prepackaged-ice-cream measure-container is referred to as a "factory container".

S. SPECIFICATIONS.

S.1. UNITS.

S.1.1. FOR RETAIL CONTAINERS.—The capacity of a retail container shall be 1 gill (or ¼ liquid pint, or 4 fluid ounces), ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, or a multiple of 1 gallon, and the container shall not be subdivided.

S.1.2. FOR FACTORY CONTAINERS.—The capacity of a factory container shall be ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, 2½ gallons, 3½ gallons, or a multiple of 1 gallon. However, any capacity less than ½ liquid pint shall be permitted.

S.2. DESIGN.

S.2.1. CAPACITY POINT.—The capacity of a measure-container shall be sharply defined by (a) the top edge, (b) a graduation near the top edge, or (c) the lowest portion of a shoulder, cap seat, lid seat, or indentation near the top edge, of the container.

S.2.2. SHAPE.—A measure-container shall be designed as some suitable geometrical shape, and its capacity shall be determined without distortion from its normal assembled shape.

S.3. MARKING.—A measure-container shall be marked with a statement of its capacity in terms of one of the units prescribed in S.1.1. and S.1.2., but a factory container of a capacity of less than ½ liquid pint shall be marked in terms of fluid ounces. If the capacity is stated in terms of the pint or quart, the word "Liquid" or the abbreviation "Liq" shall be included. The capacity statement shall be located as follows: (a) On a container with an attached closure, either on the side of the container or on that portion of the top fold that will be exposed to view when the container is closed; (b) on a container with a removable lid or cover, either on the side of the container or on both the bottom of the container and the top of the lid or cover. If the capacity point is defined by a graduation, the container shall be marked on its side with a conspicuous and suitable statement clearly identifying this graduation as the capacity point.

N. NOTES.

N.1. PREPARATION FOR TEST.—Before an actual test is begun, a measure-container shall, if necessary, be so restrained that it will maintain its normal assembled shape and that its sides will not bulge when it is filled with water. For a flat-sided container of a capacity of 1 liquid quart or less, bulging of the sides can be prevented by applying to each side of the container a metal plate or a piece of heavy cardboard only slightly smaller than the side of the container and holding these securely in place by means of tape, cord, or rubber bands. A flat-sided factory-container of a capacity of ½ gallon or more shall be supported by a rigid restraining form of a design symmetrical with that of the container. This form shall restrain not less than the entire area of the central two-thirds of each side of the container, measured from bottom to top. The inside width dimension of any side panel of the restraining form shall be $\frac{1}{16}$ inch greater than the corresponding outside dimension of the container. (The outside width dimension of any side panel of the container shall be established by adding to the inner side center-of-score to center-of-score dimension two thicknesses of the board used, and the sum thus obtained shall be rounded off to the nearest $\frac{1}{64}$ inch.)

T. TOLERANCES.

T.1.—Acceptance tolerances in excess and in deficiency shall be as shown in table 1.

TABLE 1.—ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR MEASURE-CONTAINERS

Nominal capacity	Tolerance			
	In excess		In deficiency	
	Fluid drams	*Cubic inches*	*Fluid drams*	*Cubic inches*
1/2 pint or less	3	0.6	1.5	0.3
1 pint	4	1.0	2.0	.5
1 quart	6	1.4	3.0	.7
1/2 gallon	9	2.0	4.5	1.0
1 gallon	12	2.8	6.0	1.4
Over 1 gallon	Add 12 fluid drams per gallon.	Add 2.8 cubic inches per gallon.	Add 6.0 fluid drams per gallon.	Add 1.4 cubic inches per gallon.

R. REGULATIONS.

R.1. LIMITATION OF USE.—The use of a measure-container of rectangular cross section of a capacity of ½ gallon or over shall be limited to the packaging, in advance of sale, of ice cream, sherbet, or other similar frozen desserts.

MILK BOTTLES

GENERAL CODE REFERENCES.—Milk bottles shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., and G–S.6. See also general regulations G–R.2. and G–R.3.

D. DEFINITIONS.

D.1. MILK BOTTLE.—Any bottle of the general form that has customarily been used for the measurement and delivery of milk, cream, and buttermilk at retail.

D.2. PLANE OF SEALING SURFACE.—The plane established by the under side of the bottle cap (corresponding to the plane of the cap seat), or by the under side of the crown cap or other cover if the bottle is sealed over its top (corresponding to the top edge of the bottle).

S. SPECIFICATIONS.

S.1. UNITS.—The capacity of a milk bottle shall be 1 gill, ½ liquid pint, 1 liquid pint, 1 liquid quart, ½ gallon, 1 gallon, or 2 gallons, when the temperature of the bottle is 20° C (68° F).

S.2. DESIGN.

S.2.1. CAPACITY POINT OF REGULAR MILK BOTTLE.—The capacity point of a regular bottle shall be ¼ inch below the plane of the sealing surface if the inside diameter of the bottle immediately below such plane is 2 inches or less; if such diameter is over 2 inches, the capacity point shall be a point ⅛ inch below the plane of the sealing surface.

S.2.2. CAPACITY POINT OF SPECIAL MILK BOTTLE.—If a bottle is provided with a permanent, clearly defined graduation extending at least halfway around the bottle to define the capacity point, as in bottles intended for pasteurization of milk in the bottle, this graduation may be positioned at any distance below the plane of the sealing surface up to and including the maximum distances shown in table 1, and directly over, below, or beside the graduation the words "Fill to line", or a similar and suitable statement, shall be permanently marked.

TABLE 1.—MAXIMUM DISTANCES BETWEEN GRADUATION AND PLANE OF SEALING SURFACE ON SPECIAL BOTTLES

Nominal capacity	Maximum distance between graduation and plane of sealing surface
	Inch
1/2 pint or less	5/8
1 pint	1
1 quart	1 1/2
1/2 gallon	2

S.3. MARKING.—A bottle shall be permanently marked with a statement of its capacity, and this marking shall be elsewhere than on the bottom of the bottle. (See also S.2.2.)

N. NOTES.

N.1. OPTIONAL-CLOSURE BOTTLES.—When a bottle is designed for optional, or "multiple", types of bottle closure, the plane of the lowest sealing surface shall govern for purposes of the application of specification requirements.

T. TOLERANCES.

T.1.—Maintenance and acceptance tolerances in excess and in deficiency on the average capacity of bottles shall be as shown in table 2, and shall be applied to the results of a test of not less than 25 bottles of the same capacity, pattern, make, and ownership, selected at random from the whole supply available. (The tolerance on average capacity shall be applied to the average error of the bottles tested; this average error is determined by adding together all individual errors in excess, adding together all individual errors in deficiency, subtracting the smaller sum from the greater, and dividing this result by the total number of bottles tested.) The error on any individual bottle tested shall not exceed four times the specified tolerance on average capacity. Any failure to meet individual or average tolerance requirements shall be construed as failure to conform to tolerance requirements on the part of the entire lot of bottles under examination.

TABLE 2.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, ON AVERAGE CAPACITY OF MILK BOTTLES

Nominal capacity	Tolerance on average capacity	
	Fluid drams	*Cubic inches*
1/2 pint or less	0.5	0.12
1 pint	.75	.17
1 quart	1.0	.23
1/2 gallon	1.5	.35
1 gallon	2.5	.6
2 gallons	4.5	1.0

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LUBRICATING-OIL BOTTLES

GENERAL CODE REFERENCES.—Lubricating-oil bottles shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.4., and G–S.6. See also general regulations G–R.2. and G–R.3.

D. DEFINITIONS.

D.1. LUBRICATING-OIL BOTTLE.—Any bottle used for the measurement of lubricating oil for direct delivery to the crankcase of a motor vehicle, whether or not the bottle is sealed with a cap or some other device.

S. SPECIFICATIONS.

S.1. UNITS.—The capacity of a lubricating-oil bottle shall be 1 liquid pint, 1 liquid quart, ½ gallon, or 1 gallon, when the temperature of the bottle is 20° C (68° F), and the bottle shall not be subdivided.

S.2. MATERIAL.—Bottles shall be made of clear, uncolored glass.

S.3. DESIGN.

S.3.1. CAPACITY POINT.—The capacity point shall be defined by a permanent, clearly defined graduation not more than 0.1 inch in width, extending at least halfway around the bottle, and the words "Fill to line", or a similar and suitable statement, clearly referring to this graduation, shall be permanently marked on the bottle. An auxiliary, undesignated graduation, less prominent than the capacity graduation may be placed above the capacity graduation to serve as a guide in filling the bottle with an excess measure of oil.

S.3.2. HEADSPACE.—The capacity of that portion of the bottle above the capacity graduation shall be not less than 3 cubic inches.

S.3.3. CLEARANCE ABOVE CAPACITY GRADUATION.—When any opaque top or spout that is provided is screwed firmly in place or is otherwise securely attached, the lower edge of such top or spout shall be at least ¼ inch above the capacity graduation.

S.3.4. DRAINAGE.—A bottle, and any top or spout that is provided, shall be so constructed as to permit free and unobstructed drainage of the contents of the bottle.

S.4. MARKING.—A bottle shall be permanently marked on its side with a statement of its capacity. (See also S.3.1.)

N. NOTES.

N.1. TESTING MEDIUM.—A lubricating-oil bottle shall be tested with water, the top of the meniscus of the water being brought into coincidence with the bottom of the capacity graduation.

T. TOLERANCES.

T.1.—Maintenance and acceptance tolerances in excess shall be as shown in table 1. There shall be no tolerance in deficiency.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS ONLY, FOR LUBRICATING-OIL BOTTLES

Nominal capacity	Tolerance	
	Fluid drams	*Cubic inches*
1 pint	6	1.4
1 quart	8	1.8
1/2 gallon	12	2.7
1 gallon	20	4.5

LINEAR MEASURES

GENERAL CODE REFERENCES.—Linear measures shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., and G–S.6. See also general regulations G–R.2. and G–R.3.

S. SPECIFICATIONS.

S.1. UNITS.—The total length of a linear measure may be subdivided into any or all of the following: Inches, feet, yards, and binary submultiples of the inch and the yard and multiples thereof. A 1-yard measure may also be graduated to show ⅓-yard and ⅔-yard subdivisions. Other subdivisions are allowable only on measures designed for special purposes and when required for such purposes.

S.2. PROTECTION OF ENDS.—If an end measure is made of material softer than brass, the ends of the measure shall be protected by brass (or other metal at least equally hard) securely attached.

S.3. DESIGN AND FINISH.—A rigid measure shall be straight. A folding measure shall open to a definite stop and when so opened shall be straight. Measures shall be finished smooth.

S.4 GRADUATIONS.—Graduations shall be perpendicular to the edge of the measure. Line graduations shall be not wider than 0.03 inch. Raised graduations shall be not wider than 0.12 inch at their widest point. On any measure, the width of the graduations shall not exceed one-fourth the value of the smallest graduated interval of the measure. The requirements of general specifications G-S.5.1.3. and G-S.5.2. shall not apply to linear measures.

T. TOLERANCES.

T.1. FOR MEASURES EXCEPT METAL TAPES.—Maintenance tolerances in excess and in deficiency for measures except metal tapes shall be as shown in table 1. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 1.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR LINEAR MEASURES EXCEPT METAL TAPES

Nominal interval from zero	Tolerance
Feet	*Inch*
1/2 or less	1/64
1	1/32
2	1/16
3	3/32
4	1/8
5	5/32
6	3/16

T.2. FOR METAL TAPES.—Maintenance and acceptance tolerances in excess and in deficiency for metal tapes shall be as shown in table 2, tapes of 25 feet and over being at a tension of 10 pounds, tapes of less than 25 feet being at a tension of 5 pounds, and all tapes being supported throughout on a horizontal flat surface.

TABLE 2.—MAINTENANCE AND ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR METAL TAPES

Nominal interval from zero	Tolerance
Feet	*Inch*
6 or less	1/32
7 to 30, incl	1/16
31 to 55, incl	1/8
56 to 80, incl	3/16
81 to 100, incl	1/4

R. REGULATIONS.

R.1. TACKS.—Measures constructed of tacks driven into a counter, or similar measures, shall not be used.

FABRIC-MEASURING DEVICES

GENERAL CODE REFERENCES.—Fabric-measuring devices shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.3.1., G–S.5.3.2., and G–S.6. See also general regulations G–R.1., G–R.2., G–R.3., and G–R.5.

A. APPLICATION.

A.1.—This code applies only to fabric-measuring devices, as defined, that, by reason of the character of their primary indicating elements, are obviously designed for use in connection with retail sales.

D. DEFINITIONS.

D.1. FABRIC-MEASURING DEVICE.—A mechanism or machine designed to indicate automatically the length of fabric passed through it. Means to indicate automatically the total money value of material measured, for a series of unit prices, may or may not be included.

S. SPECIFICATIONS.

S.1. UNITS.—A fabric-measuring device shall indicate lengths in terms of eighth-yards, quarter-yards, half-yards, and yards. In addition, lengths may be indicated in terms of any or all of the following subdivisions: ⅓ yard, 1/16 yard, 1 foot, and 1 inch.

S.2. CLEAR INTERVAL BETWEEN GRADUATIONS.—This shall be at least 1/16 inch for ⅛ yard graduations, and ⅛ inch for 1-inch graduations. The length graduations on a fabric-measuring device shall not be subject to the requirements of general specification G–S.5.2.

S.3. WIDTH OF INDEX OF INDICATOR.—This shall not exceed the width of the narrowest graduations with which it is used, and shall in no case exceed 0.015 inch. The requirements of general specification G–S.5.3.3. shall not apply to fabric-measuring devices.

S.4. MONEY-VALUE COMPUTATIONS.—These shall be either full-computing type (see S.4.1.) or limited-computing type (See S.4.2.).

S.4.1. FULL-COMPUTING TYPE.—In this type the money value, at each of a series of unit prices, shall be computed automatically for every length within the range of measurement of the fabric-measuring device. Value graduations shall be provided and shall be accurately positioned. The value of each graduated interval shall be 1 cent at all prices per yard of 30 cents and less, and shall not exceed 2 cents at higher prices per yard. Five-cent intervals may be represented in the 2-cent range by special graduations, but these shall not be positioned in the clear intervals between graduations of the regular series.

S.4.2. LIMITED-COMPUTING TYPE.—In this type the money values, at each of a series of unit prices, shall be computed automatically only for lengths corresponding to a definite series of length graduations. There shall be no value graduations. At no position that the chart can assume shall two value figures at the same price per yard be completely and clearly exposed to view at one time. Money values shown shall be mathematically accurate except that a fraction of less than ½ cent shall be dropped and that the next higher cent shall be shown in the case of a fraction of ½ cent or more. One of the following requirements shall be met:

(a) There shall be a money-value computation for each length graduation within the range of measurement of the device.

(b) No money-value computation shall be exposed to view except at such times as the device shows a length indication for which a corresponding series of value indications is computed.

(c) Each column or row of money-value computations shall be marked to show the length to which the computations correspond, the device shall be marked to show the character and limitations of the computations, and there shall be computations corresponding to at least ⅛ yard throughout the range of measurement of the device.

S.5. RETURN TO ZERO.—Primary indicating elements shall be readily returnable to a definite zero indication; means shall be provided to prevent the return of the indicating elements beyond their correct zero position.

S.6. LIMITATION OF USE.—If a device will not accurately measure all fabrics, it shall be marked to indicate clearly its limitations.

N. NOTES.

N.1. TESTING MEDIUM.—A fabric-measuring device shall be tested with a fabric strip approximately 2½ inches wide having a graduated length of at least 12 yards. The material and surface of this testing tape shall be such as to reduce stretch and slippage to the practicable minimum.

P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. INCREASING AND DECREASING INDICATIONS.—Indications of length and money value shall be accurate whether the values of the indications are being increased or decreased.

T. TOLERANCES.

T.1.—Maintenance tolerances on underregistration and on overregistration shall be as shown in table 1. Acceptance tolerances shall be one-half the maintenance tolerances, except that the acceptance tolerance on underregistration shall be not smaller than ¼ inch. (The error of a fabric-measuring device—to which the tolerance is applied— is the difference between the indication of the device and the corresponding actual length of testing tape passed through the device.)

TABLE 1.—MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR FABRIC-MEASURING DEVICES

Indication of device	Tolerance	
	On underregistration	On overregistration
Yards	*Inches*	*Inches*
2 or less	3/8	1/4
3	3/8	5/16
4	1/2	5/16
5	5/8	3/8
6	3/4	3/8
7 and 8	1	1/2
9	1 1/4	5/8
10 and 11	1 1/2	3/4
12 and 13	1 3/4	7/8
14 and 15	2	1
Over 15	Add 1/8 inch per indicated yard.	Add 1/16 inch per indicated yard.

CORDAGE-MEASURING DEVICES

GENERAL CODE REFERENCES.—Cordage-measuring devices shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., G–S.5.1.1., G–S.5.1.2., G–S.5.1.3., G–S.5.2., G–S.5.3.1., G–S.5.3.2., G–S.5.3.3., and G–S.6. See also general regulations G–R.1., G–R.2., G–R.3., and G–R.5.

D. DEFINITIONS.

D.1. CORDAGE-MEASURING DEVICE.—A mechanism or machine designed to indicate automatically the length of cordage, rope, wire, cable, or similar flexible material passed through it.

S. SPECIFICATIONS.

S.1. UNITS.—A cordage-measuring device shall indicate lengths in terms of feet.

S.2. DESIGN.

S.2.1. MEASURING ELEMENTS.—These shall be so constructed as to reduce to the practicable minimum any slippage of material being measured and any lost motion in gear trains.

S.2.2. INDICATING MEANS.—If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a measurement of 1 foot shall be not less than ¼ inch.

S.2.3. RETURN TO ZERO.—The primary indicating elements shall be readily returnable to a definite zero indication.

S.2.4. GRADUATIONS.—These shall be not wider than 0.04 inch.

S.2.5. INDICATORS.—If the graduations with which an indicator cooperates are of equal width, the widths of the index of the indicator and of the graduations shall be equal. If main graduations are wider than subordinate graduations, the width of the index of the indicator shall be not greater than the width of the main graduations and shall be not less than the width of the subordinate graduations.

S.3. PROVISION FOR SEALING.—If the measuring or indicating elements are adjustable, provision shall be made for applying a lead-and-wire seal or seals in such a manner that no such adjustments can be made without mutilating the seal or seals.

S.4. MARKING.

S.4.1. LIMITATION OF USE.—If a device will measure accurately only certain types or varieties of flexible materials, its limitations shall be clearly and permanently stated on the device.

S.4.2. OPERATING INSTRUCTIONS.—Any necessary operating instructions shall be clearly stated on the device.

S.4.3. INDICATIONS.—Indicating elements shall be identified by suitable words or legends so that the values of the indications will be unmistakable.

N. NOTES.

N.1. TESTING MEDIUM.—A cordage-measuring device shall be tested with a steel tape not less than ½ inch in width and 50 feet in length. The tape shall have a smooth surface or intaglio figures and graduations (i. e., the figures and graduations shall not be raised).

P. PERFORMANCE REQUIREMENTS EXCEPT TOLERANCES.

P.1. SPEED AND DIRECTION OF OPERATION.—The indications of a device shall be accurate when it is operated at any speed and in any manner that may reasonably be employed in commercial use of the device, and whether material is being passed through it in a forward or backward direction.

T. TOLERANCES.

T.1.—Maintenance tolerances on underregistration and on overregistration shall be as shown in table 1. Acceptance tolerances shall be one-half the maintenance tolerances. (The error of a cordage-measuring device—to which the tolerance is applied—is the difference between the indication of the device and the corresponding actual length of steel tape passed through the device.)

TABLE 1.—MAINTENANCE TOLERANCES, ON UNDERREGISTRATION AND ON OVERREGISTRATION, FOR CORDAGE-MEASURING DEVICES

Indication of device	Tolerance	
	On overregistration	On underregistration
Feet	*Inches*	*Inches*
0 to 20, incl	1	2
21 to 30, incl	1½	3
31 to 40, incl	2	4
41 to 50, incl	2½	5
Over 50	Add 1 inch per indicated 50 feet.	Add 2 inches per indicated 50 feet.

MILEAGE-MEASURING DEVICES

GENERAL CODE REFERENCES.—Mileage-measuring devices shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., and G–S.6. See also general regulations G–R.2., G–R.3., G–R.4., and G–R.5.

A. APPLICATION.

A.1. COMMERCIAL USE.—This code applies to taximeters, and to odometers that are used or are to be used to determine charges for hire of a vehicle.

A.2. SPECIAL USE.—When official examinations are undertaken on odometers whose readings form the basis for the payment of fees or taxes to, or the preparation of reports for, governmental agencies, and in similar cases, the requirements of this code shall be applied insofar as they are applicable and appropriate to the conditions of such special uses.

D. DEFINITIONS.

D.1. TAXIMETER.—A device that automatically calculates, at a predetermined rate or rates, and indicates, the charge for hire of a vehicle.

D.2. ODOMETER.—A device that automatically indicates the total mileage traveled by a vehicle. For the purpose of this code, this definition includes hub odometers, cable-driven odometers, and the mileage-indicating, or odometer, portions of "speedometer" assemblies for automotive vehicles.

D.3. FARE.—That portion of the charge for the hire of a vehicle that is automatically calculated by a taximeter through the operation of the mileage or time mechanism.

D.4. EXTRAS.—Charges to be paid by a passenger in addition to the fare, including any charge at a flat rate for the transportation of passengers in excess of a stated number and any charge for the transportation of baggage.

D.5. FACE.—That side of a taximeter upon which passenger charges are indicated.

D.6. SINGLE-TARIFF TAXIMETER.—One that calculates fares at a single rate only.

D.7. MULTIPLE-TARIFF TAXIMETER.—One that may be set to calculate fares at any one of two or more rates.

D.8. CLEARED.—A taximeter is "cleared" when it is inoperative with respect to all fare indication, when no indication of fare or extras is shown, and when all parts are in those positions in which they are designed to be when the vehicle on which the taximeter is or may be installed is not engaged by a passenger.

D.9. FLAG.—A plate at the end of the lever arm or similar part by which the operating condition of a taximeter is controlled.

D.10. MONEY DROP.—An increment of fare indication. The "initial money drop" is the first increment of fare indication following the flag pull.

D.11. GEAR BOX.—An assembly of change gears to permit adjustments for different tire sizes, transmission ratios, and the like.

D.12. INITIAL MILEAGE OR TIME INTERVAL.—The interval corresponding to the initial money drop.

D.13. BENCH TEST.—A test of a taximeter or odometer, with or without gear box attached, when it is not installed on a vehicle.

D.14. ROAD TEST.—A mileage test, over a measured course, of a complete taximeter or odometer assembly when installed on a vehicle, the mechanism being actuated as a result of vehicle travel.

D.15. SIMULATED ROAD TEST.—A mileage test similar to a road test except that the vehicle wheel or wheels that actuate the mechanism rest in a cradle formed by rollers, one of which is a mileage-measuring element. The vehicle remains at rest during this test.

D.16. WHEEL TEST.—A mileage test similar to a simulated road test except that the mileage results are computed from the counted number of revolutions of the actuating wheel or wheels and the mean effective circumference of tire.

S. SPECIFICATIONS.

SPECIFICATIONS APPLICABLE TO BOTH TAXIMETERS AND ODOMETERS

S.1. INCREASE OF INDICATIONS.—Except when a taximeter is being cleared or the indications of an odometer are being reduced to zero, the indications of an installed mileage-measuring device shall be susceptible of increase only by the rotation of the vehicle wheel or wheels.

S.2. PERMANENCE.—Whenever wear or deformation of ratchets and pawls and of similar combinations will affect the accuracy or consistency of indication of a mileage-measuring device, such parts shall be of such material and hardness that the wear or deformation resulting from use will be reduced to the practicable minimum.

S.3. PROVISION FOR SECURITY SEALS.—Adequate provision shall be made for affixing lead-and-wire seals to a mileage-measuring device and to other parts required for service operation of a complete installation on a vehicle, so that no adjustments, alterations, or replacements affecting in any way the accuracy or indications of the device or of the assembly can be made without mutilating the seal or seals. The sealing means shall be such that it is not necessary to disassemble or remove any part of the device or of the vehicle to apply or inspect the seals.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO TAXIMETERS

S.10. BASIS OF FARE CALCULATIONS.—A taximeter shall calculate fares only upon the basis of (a) mileage traveled, (b) time elapsed, or (c) a combination of mileage traveled and time elapsed.

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S.11. ACTUATION OF FARE-INDICATING MECHANISM.—When a taximeter designed to calculate fares upon the basis of a combination of mileage traveled and time elapsed is operative with respect to fare indication, the fare-indicating mechanism shall be actuated by the mileage mechanism whenever the vehicle is in motion at such a speed that the rate of mileage revenue equals or exceeds the time rate, and may be actuated by the time mechanism whenever the vehicle speed is less than this and when the vehicle is not in motion. Means shall be provided for the vehicle operator to render the time mechanism either operative or inoperative with respect to the fare-indicating mechanism.

S.12. REQUIRED INDICATIONS.

S.12.1. OPERATING CONDITION.—It shall be shown on a taximeter face whether or not the mechanism is set to indicate a fare and, if so, the character of fare indication for which it is set. While a taximeter is cleared, the indication "Not Registering," "Vacant," or an equivalent expression shall appear. While a single-tariff taximeter is set for fare indication, the indication "Registering," "Hired," or an equivalent expression shall appear. While a multiple-tariff taximeter is set for fare indication, the basis for the particular tariff for which it is set shall be shown; for the lowest rate the indication "Registered," "Hired," or an equivalent expression will be sufficient, but for any higher rate the indication shall be some such expression as "3 or more persons." While a taximeter is set for fare registration but with the time mechanism inoperative with respect thereto, the indication "Time Not Recording," or an equivalent expression, shall appear; this indication may replace the indication specified for a single-tariff taximeter and for the lowest rate on a multiple-tariff taximeter, but shall be in addition to the indication specified for the higher rates on a multiple-tariff taximeter.

S.12.2. ACCUMULATED FARE.—Fare indications shall be identified by the word "Fare" or by an equivalent expression. Values shall be defined by suitable words or monetary signs.

S.12.3. EXTRAS.—If an extras mechanism is provided, extras shall be indicated as a separate item and shall not be included in the fare indication. They shall be identified by the word "Extras" or by an equivalent expression. Values shall be defined by suitable words or monetary signs.

S.13. PROTECTION OF INDICATIONS.—Indications of fare and extras shall be displayed through and entirely protected by glass or other suitable transparent material securely attached to the housing of the taximeter.

S.14. VISIBILITY OF INDICATIONS.—Indications of fare and extras shall never be concealed except when the taximeter is cleared.

S.15. STATEMENT OF RATES.—The mileage and time rates for which a taximeter is adjusted, and the schedule of extras when an extras mechanism is provided, shall be marked on the taximeter face. The words "Rate", "Rates", or "Rates of Fare" shall precede the rate statement. The rate statement shall be fully informative, self-explanatory, and readily understandable by the ordinary passenger, and shall either be of a permanent character or be displayed and protected as prescribed for indications in S.13.

S.16. FLAG.—A flag shall be provided. The positions of the flag and its associated lever arm shall be mechanically defined, and displacement from any one of these positions shall be sufficiently obstructed that the accidental or inadvertent changing of the operating condition of the taximeter is improbable. The flag shall be at its highest position when the taximeter is cleared, and in this position the whole of the flag shall be above the level of the taximeter housing. Possible movement of the flag to an operating position immediately following its movement to the cleared position shall automatically be delayed enough to permit the taximeter mechanism to come to complete rest in the cleared condition.

S.17. CONTROL FOR EXTRAS MECHANISM.—The knob, handle, or other means provided to actuate the extras mechanism shall be inoperable whenever the taximeter is cleared.

S.18. INTERFERENCE.—The construction of a taximeter shall be such that there will be no interference between the time and the mileage portions of the mechanism at any speed of operation corresponding to a vehicle speed faster than the speed at which the basic rate of mileage revenue equals the basic waiting-time rate; specifically, the registration of a taximeter in the "hired" condition shall agree with its performance in the "time not recording" condition within 1 percent.

ADDITIONAL SPECIFICATIONS APPLICABLE ONLY TO ODOMETERS

S.20. UNITS.—An odometer shall indicate in terms of miles.

S.21. INDICATING ELEMENTS.

S.21.1. DESIGN.—The most sensitive indicating element of an odometer may advance either continuously or intermittently, and other indicating elements shall advance intermittently. In the case of an element that advances intermittently, movement shall be communicated to it only during that period in which there is taking place an advance of the mechanism corresponding to the tenth-mile immediately preceding the next higher indication. Means may be provided for reducing the indication to zero. The requirement of general specification G–S.4. for graduations and an indicator shall not apply to odometers.

S.21.2. READABILITY.—Mileage figures and their background shall be of sharply contrasting colors. The colors of all figures except those indicating tenth-miles shall be uniform, and the color of the tenth-mile figures shall be different from the color of the other figures. Except during the period of advance of an indicator to the next higher indication, only one figure on each drum or dial shall be exposed to view. Any protective covering intended to be transparent shall be in such condition that it can be made transparent by ordinary cleaning of its exposed surface.

NOTES, PERFORMANCE REQUIREMENTS, AND REGULATIONS APPLICABLE TO BOTH TAXIMETERS AND ODOMETERS

N. NOTES.

N.1. FORMS OF TEST.—A bench test will not develop the performance of an installed mileage-measuring device, but if used in addition to a road test, a simulated road test, or a wheel test, the latter can be simplified and can be conducted in a relatively short time. In any event, either a road test, a simulated road test, or a wheel test shall always be conducted, in order to bring into operation all of the elements of the complete installation.

N.2. INTERFERENCE TEST FOR TAXIMETERS.—As a part of the bench test if this is made, otherwise as a part of such other test as is made, a special test of a taximeter shall be made to check for possible interference between the time and mileage mechanisms, a condition that may develop at relatively slow vehicle speeds. The test consists of a comparison of taximeter performance for a nominal 1-mile interval when the taximeter is in "hired" (time-recording) condition, with its performance for a like interval when the taximeter is in "time-not-recording" condition; performance under these two conditions of operation shall agree within 1 percent. (See S.18.) Throughout this test the mechanism shall be operated at a speed corresponding to a vehicle speed of 2 or 3 miles per hour faster than the speed at which the basic mileage-revenue rate equals the basic waiting-time rate.

N.3. WORN TIRES.—For purposes of tolerance application on a road test or a simulated road test of a mileage-measuring device, a vehicle tire shall be considered to be "worn" when and after the tread wear is equivalent to approximately one-half the normal useful life of the tire. (Normally the half-life point of tire wear is reached only after the tire has been operated for at least 10,000 miles.)

N.4. MEAN EFFECTIVE TIRE CIRCUMFERENCE.—In computing mileage results on a wheel test of a mileage-measuring device and in calculating the required values for change gears, the mean effective circumference of tire shall be used. This shall be determined as follows: 1. Mount upon a vehicle a new tire of the size, kind, and make in use, and inflate this to normal operating pressure. 2. Cause the tire

to describe exactly at least three complete revolutions upon a smooth surface. 3. Measure the total distance advanced by the tire. 4. Divide this distance by the number of revolutions made, to establish the average distance advanced per revolution. 5. Subtract 1 percent from this average distance.

N.5. VEHICLE LADING AND TIRE PRESSURE.—During a road test or simulated road test of a mileage-measuring device, the vehicle shall carry an average load and its tires shall be inflated to normal operating pressure. (See R.1.)

N.6. NONUSE OF EXTRAS.—If and when taximeter extras are prohibited by legal authority or are discontinued by a vehicle operator, with respect to all taximeters involved the extras mechanisms shall be rendered inoperable or the extras indications shall be effectively obscured by permanent means.

N.7. SECURITY SEALING.—After approval of the complete assembly of an installed mileage-measuring device, suitable security seals shall be applied so that no part of the mechanism or of the connections leading thereto may be removed, or modified in such a way as to affect the accuracy of indication of the device, without mutilating the seal or seals.

T. TOLERANCES.

T.1. FOR TAXIMETERS.

T.1.1. ON MILEAGE TESTS.—Maintenance and acceptance tolerances for taximeters shall be as follows:

T.1.1.1. ON BENCH TESTS.—With respect to the nominal number of spindle revolutions:

(a) On overregistration: No tolerance.
(b) On underregistration: 2 percent of the interval under test, with an added tolerance of 100 feet whenever the initial interval is included in the interval under test.

(The error of the taximeter—to which the tolerance is applied—is the distance represented by the difference between the nominal and the actual number of spindle revolutions for the interval under test.)

T.1.1.2. ON ROAD TESTS, SIMULATED ROAD TESTS, AND WHEEL TESTS.—With respect to mileage traveled, indicated by the testing apparatus, or computed:

(a) On overregistration: No tolerance, except that on a road test or simulated road test, if the actuating tires are worn (see N.3.), the tolerance shall be 1 percent of the interval under test.

(b) On underregistration: 4 percent of the interval under test, with an added tolerance of 100 feet whenever the initial interval is included in the interval under test.

(The mileage error of the taximeter—to which the tolerance is applied—is the difference between the nominal mileage represented by the interval under test and the corresponding actual mileage traveled, indicated, or computed.)

T.1.2. ON TIME TESTS.—Maintenance and acceptance tolerances shall be as follows:

T.1.2.1. ON INDIVIDUAL TIME INTERVALS:

(a) On overregistration: 3 seconds per minute (5 percent).

(b) On underregistration: 9 seconds per minute (15 percent) on the initial interval, and 6 seconds per minute (10 percent) on other intervals.

T.1.2.2. ON AVERAGE TIME INTERVAL COMPUTED AFTER EXCLUDING THE INITIAL INTERVAL:

(a) On overregistration: No tolerance.

(b) On underregistration: 3 seconds per minute (5 percent).

(The errors of the taximeter on individual or average time intervals—to which the tolerances are applied—are the differences between the nominal intervals and the corresponding actual intervals measured or computed.)

T.2. FOR ODOMETERS.—Maintenance and acceptance tolerances on mileage tests of odometers shall be as follows:

(a) On overregistration: No tolerance, except that on a road test or a simulated road test, if the actuating tires are worn (see N.3.), the tolerance shall be 1 percent of the interval under test.

(b) On underregistration: 4 percent of the interval under test.

(The error of the odometer—to which the tolerance is applied—is the difference between the mileage indication of the odometer for the interval under test and the corresponding mileage actually traveled, indicated, or computed.)

R. REGULATIONS.

R.1. INFLATION OF VEHICLE TIRES.—The pressure in vehicle tires that actuate a mileage-measuring device shall be maintained at not less than the normal operating pressure established in advance for such tires by the operator of the vehicle. Such pressure shall in no case be less than the pressure recommended by the manufacturer for tires of that particular size, kind, and make.

R.2. REINSPECTION.—Whenever a mileage-measuring device has been damaged, or repairs that might in any way affect the accuracy of its indications have been made, or any of the official security seals have been mutilated, such device shall not thereafter be used until it has been officially examined and reapproved.

R.3. POSITION AND ILLUMINATION OF TAXIMETER.—When mounted upon a vehicle, a taximeter shall be so placed that its face is in plain view of a passenger seated upon the rear seat of the vehicle. Adequate lighting facilities shall be provided for so illuminating the face of the taximeter that the indications thereof may be conveniently read by the passenger, and the face of the taximeter shall be so illuminated whenever the taximeter is in operation and artificial illumination is necessary for the convenient reading of its indications.

DRY MEASURES [8]

GENERAL CODE REFERENCES.—Dry measures shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., G–S.4., and G–S.6. See also general regulations G–R.2. and G–R.3.

A. APPLICATION.

A.1.—This code does not apply to "standard containers" used for the measurement of fruits and vegetables and as shipping containers therefor.

D. DEFINITIONS.

D.1. DRY MEASURE.—A rigid measure of capacity, designed for general and repeated use in the measurement of solids, including baskets used as dry measures in capacities of ½ bushel or more.

S. SPECIFICATIONS.

S.1. UNITS.—The capacity of a measure shall be 1 bushel, a multiple of the bushel, or a binary submultiple of the bushel, and the measure shall not be subdivided or double-ended.

S.2. DESIGN.

S.2.1. CAPACITY POINT.—The capacity of a measure shall be determined by the top edge of the measure.

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[8] This code should not be promulgated in any jurisdiction in which the use of dry measures is prohibited by law.

S.2.2. SHAPE.—A measure, other than a basket, of a capacity of ½ bushel or less, shall be cylindrical or conical in shape; if conical, the top diameter shall exceed the bottom diameter, but by not more than 10 percent of the bottom diameter; and the top diameter shall in no case be less than the appropriate minimum diameter shown in table 1. The bottom of a measure, other than a basket, shall be perpendicular to the axis of the measure and shall be flat, except that a metal bottom may be slightly corrugated. The bottom of a measure shall not be adjustable or movable.

TABLE 1.—MINIMUM TOP DIAMETERS FOR DRY MEASURES OTHER THAN BASKETS

Nominal capacity	Minimum top diameter
	Inches
1 pint	4
1 quart	5 3/8
2 quarts	6 5/8
1/2 peck	8 1/2
1 peck	10 7/8
1/2 bushel	13 3/4

S.2.3. TOP REINFORCEMENT.—The top edge of a measure shall be reinforced; on a wooden measure other than a basket, of a capacity of 1 quart or more, this reinforcement shall be in the form of a firmly attached metal band.

S.3. MARKING.—A measure shall be conspicuously marked on its side with a statement of its capacity; if the capacity is stated in terms of the pint or quart, the word "Dry" shall be included. The capacity statement shall be in letters at least ½ inch high and ¼ inch wide on a measure of any capacity between ¼ pint and 1 peck, and in letters at least 1 inch high and ½ inch wide on a measure of a capacity of ½ bushel or more; the statement on a measure of a capacity of ⅛ pint and less shall be as prominent as practicable, considering the size and design of such measure.

T. TOLERANCES.

T.1.—Maintenance tolerances in excess and in deficiency shall be as shown in table 2. Acceptance tolerances shall be one-half the maintenance tolerances.

TABLE 2.—MAINTENANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR DRY MEASURES

Nominal capacity	Tolerance	
	In excess	In deficiency
	Cubic inches	*Cubic inches*
1/32 pint or less	0.1	0.05
1/16 pint	.15	.1
1/8 pint	.25	.15
1/4 pint	.5	.3
1/2 pint	1.0	.5
1 pint	2.0	1.0
1 quart	3.0	1.5
2 quarts	5.0	2.5
1/2 peck	10.0	5.0
1 peck	16.0	8.0
1/2 bushel	30.0	15.0
1 bushel	50.0	25.0

BERRY BASKETS AND BOXES

GENERAL CODE REFERENCES.—Berry baskets and boxes shall conform to all of the applicable requirements of the General Code, particularly general specifications G–S.1., G–S.2., G–S.3., and G–S.6. See also general regulations G–R.2. and G–R. 3.

A. APPLICATION.

A.1.—This code applies to baskets and boxes for berries and small fruits in capacities of 1 dry quart and less.

S. SPECIFICATIONS.

S.1. UNITS.—The capacity of a berry basket or box shall be ½ dry pint, 1 dry pint, or 1 dry quart.

T. TOLERANCES.

T.1.—Acceptance tolerances in excess and in deficiency shall be as shown in table 1.

TABLE 1.—ACCEPTANCE TOLERANCES, IN EXCESS AND IN DEFICIENCY, FOR BERRY BASKETS AND BOXES

Nominal capacity	Tolerance	
	In excess	In deficiency
	Cubic inches	*Cubic inches*
½ pint	1	0. 5
1 pint	2	1. 0
1 quart	3	1. 5

INDEX OF DEFINITIONS [9]

References are given by code designation, paragraph designation, and page number. Codes are designated as follows:

Designation	*Full Name*
C-MD	Cordage-Measuring Devices
F-MD	Fabric-Measuring Devices
FMT	Farm Milk Tanks
General	General Code
Graduates	Graduates
LM	Liquid Measures
L-MD	Liquid-Measuring Devices
L-OB	Lubricating-Oil Bottles
MB	Milk Bottles
MC	Measure-Containers
M-MD	Mileage-Measuring Devices
Scales	Scales
VT	Vehicle Tanks
Weights	Weights

A

[9] It is inevitable that as changes in and additions to the several codes are made by the National Conference from time to time, this index will, to a limited extent, become inaccurate and incomplete. Correction and replacement sheets will not be issued with respect to this index. The holder of a copy of the Handbook can, however, keep this index correct at all times by annotating it appropriately whenever changes shown on the correction or replacement sheets for the text are such as to involve changes in the index.

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SEQUENTIAL PARAGRAPH INDEX[10]

GENERAL CODE

[10] It is inevitable that as changes in and additions to the several codes are made by the National Conference from time to time, this index will, to a limited extent, become inaccurate and incomplete. Correction and replacement sheets will not be issued with respect to this index. The holder of a copy of the Handbook can, however, keep this index correct at all times by annotating it appropriately whenever changes shown on the correction or replacement sheets for the text are such as to involve changes in the index.

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Appendix.—GENERAL TABLES OF WEIGHTS AND MEASURES

Part 1. TABLES OF UNITED STATES CUSTOMARY WEIGHTS AND MEASURES

LINEAR MEASURE

12 inches (in.) = 1 foot (ft)
3 feet = 1 yard (yd) = 36 inches
5½ yards = 1 rod (rd), pole, or perch = 16½ feet
40 rods = 1 furlong (fur.) = 220 yards = 660 feet
8 furlongs = 1 statute mile (mi) = 1 760 yards = 5 280 feet
3 miles = 1 league = 5 280 yards = 15 840 feet

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6 076.10333... feet (1 852 meters) = 1 international nautical mile. This value was adopted, effective July 1, 1954, for use in the United States. The value formerly used in the United States was 6 080.20 feet = 1 nautical (geographical or sea) mile.

AREA MEASURE [1]

144 square inches (sq in.) = 1 square foot (sq ft)
9 square feet = 1 square yard (sq yd) = 1 296 square inches
30¼ square yards = 1 square rod (sq rd) = 272¼ square feet
160 square rods = 1 acre = 4 840 square yards = 43 560 square feet
640 acres = 1 square mile (sq mi)
1 mile square = 1 section [of land]
6 miles square = 1 township = 36 sections = 36 square miles

CUBIC MEASURE [2]

1 728 cubic inches (cu in.) = 1 cubic foot (cu ft)
27 cubic feet = 1 cubic yard (cu yd)

GUNTER'S OR SURVEYORS CHAIN MEASURE

7.92 inches (in.) = 1 link (li)
100 links = 1 chain (ch) = 4 rods = 66 feet
80 chains = 1 statute mile (mi) = 320 rods = 5 280 feet

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[1] Squares of units are sometimes abbreviated by using the superior figure 2. For example, ft^2 means square foot or feet.
[2] Cubes of units are sometines abbreviated by using the superior figure 3. For example, ft^3 means cubic foot or feet.

LIQUID MEASURE [3]

4 gills (gi) = 1 pint (pt) [=28.875 cubic inches]
2 pints = 1 quart (qt) [=57.75 cubic inches]
4 quarts = 1 gallon (gal) [=231 cubic inches] = 8 pints = 32 gills

APOTHECARIES FLUID MEASURE

60 minims (min or ℿ) = 1 fluid dram (fl dr or f ʒ) [=0.225 6 cubic inch]
8 fluid drams = 1 fluid ounce (fl oz or f ℥) [=1.804 7 cubic inches]
16 fluid ounces = 1 pint (pt or O) [=28.875 cubic inches] = 128 fluid drams
2 pints = 1 quart (qt) [=57.75 cubic inches] = 32 fluid ounces = 256 fluid drams
4 quarts = 1 gallon (gal) [=231 cubic inches] = 128 fluid ounces = 1 024 fluid drams

DRY MEASURE [4]

2 pints (pt) = 1 quart (qt) [=67.200 6 cubic inches]
8 quarts = 1 peck (pk) [=537.605 cubic inches] = 16 pints
4 pecks = 1 bushel (bu) [=2 150.42 cubic inches] = 32 quarts

AVOIRDUPOIS WEIGHT [5]

[The "grain" is the same in avoirdupois, troy, and apothecaries weight.]

27 11/32 grains = 1 dram (dr)
16 drams = 1 ounce (oz) = 437½ grains
16 ounces = 1 pound (lb) = 256 drams = 7 000 grains
100 pounds = 1 hundredweight (cwt) [6]
20 hundredweights = 1 ton (tn) = 2 000 pounds [6]

In "gross" or "long" measure, the following values are recognized:

112 pounds = 1 gross or long hundredweight [6]
20 gross or long hundredweights = 1 gross or long ton = 2 240 pounds [6]

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[3] When necessary to distinguish the *liquid* pint or quart from the *dry* pint or quart, the word "liquid" or the abbreviation "liq" should be used in combination with the name or abbreviation of the name of the *liquid* unit.

[4] When necessary to distinguish the *dry* pint or quart from the *liquid* pint or quart, the word "dry" should be used in combination with the name or abbreviation of the name of the *dry* unit.

[5] When necessary to distinguish the *avoirdupois* dram from the *apothecaries* dram, or to distinguish the *avoirdupois* dram or ounce from the *fluid* dram or ounce, or to distinguish the *avoirdupois* ounce or pound from the *troy* or *apothecaries* ounce or pound, the word "avoirdupois" or the abbreviation "avdp" should be used in combination with the name or abbreviation of the *avoirdupois* unit.

[6] When the terms "hundredweight" and "ton" are used unmodified, they are commonly understood to mean the 100-pound hundredweight and the 2 000-pound ton, respectively; these units may be designated "net" or "short" when necessary to distinguish them from the corresponding units in *gross* or *long* measure.

TROY WEIGHT

[The "grain" is the same in avoirdupois, troy, and apothecaries weight.]

24 grains = 1 pennyweight (dwt)
20 pennyweights = 1 ounce troy (oz t) = 480 grains
12 ounces, troy = 1 pound troy (lb t) = 240 pennyweights = 5 760 grains

APOTHECARIES WEIGHT

[The "grain" is the same in avoirdupois, troy, and apothecaries weight.]

20 grains = 1 scruple (s ap or ℈)
3 scruples = 1 dram apothecaries (dr ap or ʒ) = 60 grains
8 drams, apothecaries = 1 ounce apothecaries (oz ap or ℥) = 24 scruples = 480 grains
12 ounces, apothecaries = 1 pound apothecaries (lb ap or ℔) = 96 drams apothecaries = 288 scruples = 5 760 grains

Part 2. NOTES ON BRITISH WEIGHTS AND MEASURES TABLES

In Great Britain, the yard, the avoirdupois pound, the troy pound, and the apothecaries pound, are, for all commercial purposes, identical with the units of the same names used in the United States. The tables of British linear measure, troy weight, and apothecaries weight are the same as the corresponding United States tables, except for the British spelling "drachm" in the table of apothecaries weight. The table of British avoirdupois weight is the same as the United States table up to 1 pound; above that point the table reads:

14 pounds = 1 stone
2 stones = 1 quarter = 28 pounds
4 quarters = 1 hundredweight = 112 pounds
20 hundredweight = 1 ton = 2 240 pounds

The present British gallon and bushel, known as the "Imperial gallon" and "Imperial bushel" are, respectively, about 20 percent and 3 percent larger than the United States gallon and bushel. The Imperial gallon is defined as the volume of 10 avoirdupois pounds of water under specified conditions, and the Imperial bushel is defined as 8 Imperial gallons. Also, the subdivision of the Imperial gallon as presented in the table of British apothecaries measure differs in two important respects from the corresponding United States subdivision, in that the Imperial gallon is divided into 160 fluid ounces (whereas the United States gallon is divided into 128 fluid ounces), and a "fluid scruple" is included. The full table of British measures of capacity (which are used alike for liquid and for dry commodities) is as follows:

4 gills	=1 pint
2 pints	=1 quart
4 quarts	=1 gallon
2 gallons	=1 peck
8 gallons [4 pecks]	=1 bushel
8 bushels	=1 quarter

The full table of British apothecaries measure is as follows:

20 minims	=1 fluid scruple
3 fluid scruples	=1 fluid drachm=60 minims
8 fluid drachms	=1 fluid ounce
20 fluid ounces	=1 pint
8 pints	=1 gallon=160 fluid ounces

Part 3. TABLES OF METRIC WEIGHTS AND MEASURES

LINEAR MEASURE

10 millimeters (mm)	=1 centimeter (cm)
10 centimeters	=1 decimeter (dm)=100 millimeters
10 decimeters	=1 meter (m)=1 000 millimeters
10 meters	=1 dekameter (dkm)
10 dekameters	=1 hectometer (hm)=100 meters
10 hectometers	=1 kilometer (km)=1 000 meters

AREA MEASURE

100 square millimeters (mm^2)	=1 square centimeter (cm^2)
10 000 square centimeters	=1 square meter (m^2)=1 000 000 square millimeters
100 square meters	=1 are (a)
100 ares	=1 hectare (ha)=10 000 square meters
100 hectares	=1 square kilometer (km^2)=1 000 000 square meters

VOLUME MEASURE

10 milliliters (ml)	=1 centiliter (cl)
10 centiliters	=1 deciliter (dl)=100 milliliters
10 deciliters	=1 liter [7] (l)=1 000 milliliters
10 liters	=1 dekaliter (dkl)
10 dekaliters	=1 hectoliter (hl)=100 liters
10 hectoliters	=1 kiloliter (kl)=1 000 liters

[7] The liter is defined as the volume occupied, under standard conditions, by a quantity of pure water having a mass of 1 kilogram. This volume is very nearly equal to 1 000 cubic centimeters or 1 cubic decimeter; the actual metric equivalent is, 1 liter = 1 000.028 cubic centimeters. (The change in this equivalent from the previously published value of 1 000.027 is based on a recomputation of earlier data, carried out at the International Bureau of Weights and Measures.) Thus the milliliter and the liter are larger than the cubic centimeter and the cubic decimeter, respecitively, by 28 parts in 1 000 000; except for determinations of high precision, this difference is so small as to be of no consequence.

CUBIC MEASURE

1 000 cubic millimeters (mm^3) = 1 cubic centimeter (cm^3)
1 000 cubic centimeters = 1 cubic decimeter (dm^3) = 1 000 000 cubic millimeters
1 000 cubic decimeters = 1 cubic meter (m^3) = 1 stere = 1 000 000 cubic centimeters = 1 000 000 000 cubic millimeters

WEIGHT

10 milligrams (mg) = 1 centigram (cg)
10 centigrams = 1 decigram (dg) = 100 milligrams
10 decigrams = 1 gram (g) = 1 000 milligrams
10 grams = 1 dekagram (dkg)
10 dekagrams = 1 hectogram (hg) = 100 grams
10 hectograms = 1 kilogram (kg) = 1 000 grams
1 000 kilograms = 1 metric ton (t)

NOTE.—In the metric system of weights and measures, designations of multiples and subdivisions of any unit may be arrived at by combining with the name of the unit the prefixes *deka*, *hecto*, and *kilo*, meaning, respectively, 10, 100, and 1 000, and *deci*, *centi*, and *milli*, meaning, respectively, one-tenth, one-hundredth, and one-thousandth. In some of the foregoing metric tables, some such multiples and subdivisions have not been included for the reason that these have little, if any, currency in actual usage.

In certain cases, particularly in scientific usage, it becomes convenient to provide for multiples larger than 1 000 and for subdivisions smaller than one-thousandth. Accordingly, the following prefixes have been introduced and these are now generally recognized.

myria, meaning 10 000
mega, meaning 1 000 000
micro, meaning one-millionth

A special case is found in the term "micron" (abbreviated as μ [the Greek letter mu]), a coined word meaning one-millionth of a meter (equivalent to one-thousandth of a millimeter); a millimicron (abbreviated as mμ) is one-thousandth of a micron (equivalent to one-millionth of a millimeter), and a micromicron (abbreviated as $\mu\mu$) is one-millionth of a micron (equivalent to one-thousandth of a millimicron or to 0.000 000 001 millimeter.)

Part 4. TABLES OF INTERRELATION OF UNITS OF MEASUREMENT

[Exact equivalents are indicated by bold face type]

UNITS OF LENGTH

Units		Inches	Links •	Feet	Yards	Rods
1 inch	=	**1**	0.126 263	0.083 333 3	0.027 777 8	0.005 050 51
1 link	=	**7.92**	**1**	**0.66**	**0.22**	**0.04**
1 foot	=	**12**	1.515 152	**1**	0.333 333	0.060 606 1
1 yard	=	**36**	4.545 45	**3**	**1**	0.181 818
1 rod	=	**198**	**25**	**16.5**	**5.5**	**1**
1 chain	=	**792**	**100**	**66**	**22**	**4**
1 mile	=	**63 360**	**8000**	**5280**	**1760**	**320**
1 centimeter	=	**0.3937**	0.049 709 60	0.032 808 33	0.010 936 111	0.001 988 384
1 meter	=	**39.37**	4.970 960	3.280 833	1.093 611 1	0.198 838 4

Units		Chains •	Miles	Centimeters	Meters
1 inch	=	0.001 262 63	0.000 015 782 8	**2.540 005**	**0.025 400 05**
1 link	=	**0.01**	**0.000 125**	**20.116 84**	**0.201 168 4**
1 foot	=	0.015 151 5	0.000 189 393 9	**30.480 06**	**0.304 800 6**
1 yard	=	0.045 454 5	0.000 568 182	**91.440 18**	**0.914 401 8**
1 rod	=	**0.25**	**0.003 125**	**502.9210**	**5.029 210**
1 chain	=	**1**	**0.0125**	**2011.684**	**20.116 84**
1 mile	=	**80**	**1**	**160 934.72**	**1609.3472**
1 centimeter	=	0.000 497 096 0	0.000 006 213 699	**1**	**0.01**
1 meter	=	0.049 709 60	0.000 621 369 9	**100**	**1**

• Gunter's or Surveyors.

UNITS OF AREA

Units		Square inches	Square links [a]	Square feet
1 square inch	=	1	0.015 942 3	0.006 944 44
1 square link	=	62.7264	1	0.4356
1 square foot	=	144	2.295 684	1
1 square yard	=	1296	20.6612	9
1 square rod	=	39 204	625	272.25
1 square chain	=	627 264	10 000	4356
1 acre	=	6 272 640	100 000	43 560
1 square mile	=	4 014 489 600	64 000 000	27 878 400
1 square centimeter	=	0.154 999 69	0.002 471 04	0.001 076 387
1 square meter	=	1549.9969	24.7104	10.763 87
1 hectare	=	15 499 969	247 104	107.638.7

Units		Square yards	Square rods	Square chains [a]
1 square inch	=	0.000 771 605	0.000 025 507 6	0.000 001 594 23
1 square link	=	0.0484	0.0016	0.0001
1 square foot	=	0.111 111 1	0.003 673 09	0.000 229 568
1 square yard	=	1	0.033 057 85	0.002 066 12
1 square rod	=	30.25	1	0.0625
1 square chain	=	484	16	1
1 acre	=	4840	160	10
1 square mile	=	3 097 600	102 400	6400
1 square centimeter	=	0.000 119 598 5	0.000 003 953 67	0.000 000 247 104
1 square meter	=	1.195 985	0.039 536 7	0.002 471 04
1 hectare	=	11 959.85	395.367	24.7104

Units		Acres	Square miles
1 square inch	=	0.000 000 159 423	0.000 000 000 249 1
1 square link	=	0.000 01	0.000 000 015 625
1 square foot	=	0.000 022 956 8	0.000 000 035 870 1
1 square yard	=	0.000 206 612	0.000 000 322 831
1 square rod	=	0.006 25	0.000 009 765 625
1 square chain	=	0.1	0.000 156 25
1 acre	=	1	0.001 562 5
1 square mile	=	640	1
1 square centimeter	=	0.000 000 024 710 4	0.000 000 000 038 610 06
1 square meter	=	0.000 247 104	0.000 000 386 100 6
1 hectare	=	2.471 04	0.003 861 006

Units		Square centimeters	Square meters	Hectares
1 square inch	=	6.451 626	0.000 645 162 6	0.000 000 064 516
1 square link	=	404.6873	0.040 468 73	0.000 004 046 87
1 square foot	=	929.0341	0.092 903 41	0.000 009 290 34
1 square yard	=	8361.307	0.836 130 7	0.000 083 613 1
1 square rod	=	252 929.5	25.292 95	0.002 529 295
1 square chain	=	4 046 873	404.6873	0.040 468 7
1 acre	=	40 468 726	4046.873	0.404 687
1 square mile	=	25 899 984 703	2 589 998	258.9998
1 square centimeter	=	1	0.0001	0.000 000 01
1 square meter	=	10 000	1	0.0001
1 hectare	=	100 000 000	10 000	1

[a] Gunter's or Surveyors.

UNITS OF VOLUME

Units		Cubic inches	Cubic feet	Cubic yards
1 cubic inch	=	1	0.000 578 704	0.000 021 433 47
1 cubic foot	=	1728	1	0.037 037 0
1 cubic yard	=	46 656	27	1
1 cubic centimeter	=	0.061 023 38	0.000 035 314 45	0.000 001 307 94
1 cubic decimeter	=	61.023 38	0.035 314 45	0.001 307 943
1 cubic meter	=	61 023.38	35.314 45	1.307 942 8

Units		Cubic centimeters	Cubic decimeters	Cubic meters
1 cubic inch	=	16.387 162	0.016 387 16	0.000 016 387 16
1 cubic foot	=	28 317.016	28.317 016	0.028 317 016
1 cubic yard	=	764 559.4	764.5594	0.764 559 4
1 cubic centimeter	=	1	0.001	0.000 001
1 cubic decimeter	=	1 000	1	0.001
1 cubic meter	=	1 000 000	1000	1

UNITS OF CAPACITY—LIQUID MEASURE [8]

Units		Minims	Fluid drams	Fluid ounces	Gills
1 minim	=	1	0.016 666 7	0.002 083 33	0.000 520 833
1 fluid dram	=	60	1	0.125	0.031 25
1 fluid ounce	=	480	8	1	0.25
1 gill	=	1920	32	4	1
1 liquid pint	=	7680	128	16	4
1 liquid quart	=	15 360	256	32	8
1 gallon	=	61 440	1024	128	32
1 milliliter	=	16.2311	0.270 518	0.033 814 8	0.008 453 69
1 liter	=	16 231.1	270.518	33.814 8	8.453 69
1 cubic inch	=	265 974	4.432 90	0.554 113	0.138 528
1 cubic foot	=	459 603	7660.05	957.506	239.377

Units		Liquid pints	Liquid quarts	Gallons	Milliliters
1 minim	=	0.000 130 208	0.000 065 104	0.000 916 276	0.061 610 2
1 fluid dram	=	0.007 812 5	0.003 906 25	0.000 976 562	3.696 61
1 fluid ounce	=	0.0625	0.031 25	0.007 812 5	29.5729
1 gill	=	0.25	0.125	0.031 25	118.292
1 liquid pint	=	1	0.5	0.125	473.166
1 liquid quart	=	2	1	0.25	946.332
1 gallon	=	8	4	1	3785.329
1 milliliter	=	0.002 113 42	0.001 056 71	0.000 264 178	1
1 liter	=	2.113 42	1.056 71	0.264 178	1000
1 cubic inch	=	0.034 632 0	0.017 316 0	0.004 329 00	16.3867
1 cubic foot	=	59.8442	29.9221	7.480 52	28 316.22

See footnote at end of table.

UNITS OF CAPACITY—LIQUID MEASURE[8]—Continued

Units		Liters	Cubic inches	Cubic feet
1 minim	=	0.000 061 610 2	0.003 759 77	0.000 002 175 79
1 fluid dram	=	0.003 696 61	0.225 586	0.000 130 547
1 fluid ounce	=	0.029 572 9	1.804 69	0.001 044 38
1 gill	=	0.118 292	7.218 75	0.004 177 52
1 liquid pint	=	0.473 166	28.875	0.016 710 1
1 liquid quart	=	0.946 332	57.75	0.033 420 1
1 gallon	=	3.785 329	231	0.133 681
1 milliliter	=	0.001	0.061 025 1	0.000 035 315 4
1 liter	=	1	61.025 1	0.035 315 4
1 cubic inch	=	0.016 386 7	1	0.000 578 704
1 cubic foot	=	28.316 22	1728	1

[8] See also table of equivalents between U. S. and British liquid measure units, p. 193.

UNITS OF CAPACITY—DRY MEASURE

Units		Dry pints	Dry quarts	Pecks	Bushels
1 dry pint	=	1	0.5	0.0625	0.015 625
1 dry quart	=	2	1	0.125	0.031 25
1 peck	=	16	8	1	0.25
1 bushel	=	64	32	4	1
1 liter	=	1.816 21	0.908 103	0.113 513	0.028 378
1 dekaliter	=	18.1621	9.081 03	1.135 13	0.283 78
1 cubic inch	=	0.029 761 6	0.014 880 8	0.001 860 10	0.000 465 025
1 cubic foot	=	51.4281	25.7140	3.214 26	0.803 564

Units		Liters	Dekaliters	Cubic inches	Cubic feet
1 dry pint	=	0.550 598	0.055 059 8	33.600 312 5	0.019 444 6
1 dry quart	=	1.101 197	0.110 119 7	67.200 625	0.038 889 3
1 peck	=	8.809 57	0.880 957	537.605	0.311 114
1 bushel	=	35.2383	3.523 83	2150.42	1.244 456
1 liter	=	1	0.1	61.0251	0.035 315 4
1 dekaliter	=	10	1	610.251	0.353 154
1 cubic inch	=	0.016 386 7	0.001 638 67	1	0.000 578 704
1 cubic foot	=	28.316 2	2.831 62	1728	1

UNITS OF MASS NOT GREATER THAN POUNDS AND KILOGRAMS

Units		Grains	Apothecaries scruples	Pennyweights
1 grain	=	1	0.05	0.041 666 67
1 apothecaries scruple	=	20	1	0.833 333 3
1 pennyweight	=	24	1.2	1
1 avoirdupois dram	=	27.343 75	1.367 187 5	1.139 323
1 apothecaries dram	=	60	3	2.5
1 avoirdupois ounce	=	437.5	21.875	18.229 17
1 apothecaries or troy ounce	=	480	24	20
1 apothecaries or troy pound	=	5760	288	240
1 avoirdupois pound	=	7000	350	291.6667
1 milligram	=	0.015 432 356	0.000 771 618	0.000 643 014 8
1 gram	=	15.432 356	0.771 618	0.643 014 85
1 kilogram	=	15 432.356	771.6178	643.014 85

UNITS OF MASS NOT GREATER THAN POUNDS AND KILOGRAMS—Continued

Units		Avoirdupois drams	Apothecaries drams	Avoirdupois ounces
1 grain	=	0.036 571 43	0.016 666 7	0.002 285 71
1 apothecaries scruple	=	0.731 428 6	0.333 333	0.045 714 3
1 pennyweight	=	0.877 714 3	**0.4**	0.054 857 1
1 avoirdupois dram	=	1	0.455 729 2	**0.0625**
1 apothecaries dram	=	2.194 286	1	0.137 142 9
1 avoirdupois ounce	=	16	7.291 67	1
1 apothecaries or troy ounce	=	17.554 28	8	1.097 142 9
1 apothecaries or troy pound	=	210.6514	96	13.165 714
1 avoirdupois pound	=	256	116.6667	16
1 milligram	=	0.000 564 383 3	0.000 257 205 9	0.000 035 273 96
1 gram	=	0.564 383 3	0.257 205 9	0.035 273 96
1 kilogram	=	564.383 32	257.205 94	35.273 96

Units		Apothecaries or troy ounces	Apothecaries or troy pounds	Avoirdupois pounds
1 grain	=	0.002 083 33	0.000 173 611 1	0.000 142 857 1
1 apothecaries scruple	=	0.041 666 7	0.003 472 222	0.002 857 143
1 pennyweight	=	**0.05**	0.004 166 667	0.003 428 571
1 avoirdupois dram	=	0.056 966 146	0.004 747 178 8	**0.003 906 25**
1 apothecaries dram	=	**0.125**	0.010 416 667	0.008 571 429
1 avoirdupois ounce	=	0.911 458 3	0.075 954 861	**0.0625**
1 apothecaries or troy ounce	=	1	0.083 333 33	0.068 571 43
1 apothecaries or troy pound	=	12	1	0.822 857 1
1 avoirdupois pound	=	14.583 333	1.215 277 8	1
1 milligram	=	0.000 032 150 74	0.000 002 679 23	0.000 002 204 62
1 gram	=	0.032 150 74	0.002 679 23	0.002 204 62
1 kilogram	=	32.150 742	2.679 228 5	2.204 622 341

Units		Milligrams	Grams	Kilograms
1 grain	=	64.798 918	0.064 798 918	0.000 064 798 9
1 apothecaries scruple	=	1295.9784	1.295 978 4	0.001 295 978
1 pennyweight	=	1555.1740	1.555 174 0	0.001 555 174
1 avoirdupois dram	=	1771.8454	1.771 845 4	0.001 771 845
1 apothecaries dram	=	3887.9351	3.887 935 1	0.003 887 935
1 avoirdupois ounce	=	28 349.527	28.349 527	0.028 349 53
1 apothecaries or troy ounce	=	31 103.481	31.103 481	0.031 103 48
1 apothecaries or troy pound	=	373 241.77	373.241 77	0.373 241 77
1 avoirdupois pound	=	**453 592.4277**	**453.592 427 7**	**0.453 592 427 7**
1 milligram	=	1	**0.001**	**0.000 001**
1 gram	=	1000	1	**0.001**
1 kilogram	=	**1 000 000**	1000	1

UNITS OF MASS NOT LESS THAN AVOIRDUPOIS OUNCES

Units	Avoirdupois ounces	Avoirdupois pounds	Short hundredweights	Short tons
1 avoirdupois ounce =	1	0.0625	0.000 625	0.000 031 25
1 avoirdupois pound =	16	1	0.01	0.0005
1 short hundredweight =	1600	100	1	0.05
1 short ton =	32 000	2000	20	1
1 long ton =	35 840	2240	22.4	1.12
1 kilogram =	35.273 957	2.204 622 34	0.022 046 223	0.001 102 311 2
1 metric ton =	35 273.957	2204.622 34	22.046 223	1.102 311 2

Units	Long tons	Kilograms	Metric tons
1 avoirdupois ounce =	0.000 027 901 79	0.028 349 53	0.000 028 349 53
1 avoirdupois pound =	0.000 446 428 6	0.453 592 427 7	0.000 453 592 43
1 short hundredweight =	0.044 642 86	45.359 243	0.045 359 243
1 short ton =	0.892 857 1	907.184 86	0.907 184 86
1 long ton =	1	1016.047 04	1.016 047 04
1 kilogram =	0.000 984 206 4	1	0.001
1 metric ton =	0.984 206 40	1000	1

Part 5. TABLES OF EQUIVALENTS

NOTES.—When the name of a unit is enclosed in brackets (thus, [1 hand] . . .), this indicates (1) that the unit is not in general current use in the United States, or (2) that the unit is believed to be based on "custom and usage" rather than on formal authoritative definition.

Equivalents involving decimals are, in most instances, rounded off to the third decimal place except where they are exact, in which cases these exact equivalents are so designated.

LENGTHS

1 angstrom (A) [9]
- 0.1 millimicron.
- 0.000 1 micron.
- 0.000 000 1 millimeter.
- 0.000 000 004 inch.

1 cable's length
- 120 fathoms.
- 720 feet.
- 219.456 meters.

1 centimeter (cm) — 0.393 7 inch (exactly).

1 chain (ch) (Gunter's or surveyors')
- 66 feet.
- 20.117 meters.

[1 chain (engineers)]
- 100 feet.
- 30.480 meters.

1 decimeter (dm) — 3.937 inches (exactly).

1 dekameter (dkm) — 32.808 feet.

[9] The Angstrom is basically defined as 6438.4696 wave lengths of red cadmi under specified conditions.

1 fathom	6 feet. 1.829 meters.
1 foot (ft)	0.305 meter.
1 furlong (fur.)	10 chains (surveyors). 660 feet. 220 yards. ⅛ statute mile. 201.168 meters.
[1 hand]	4 inches.
1 inch (in.)	2.540 centimeters.
1 kilometer (km)	0.621 mile.
1 league (land)	3 statute miles. 4.828 kilometers.
1 link (li) (Gunter's or surveyors)	7.92 inches (exactly). 0.201 meter.
[1 link (li) (engineers)]	1 foot. 0.305 meter.
1 meter (m)	39.37 inches (exactly). 1.094 yards.
1 micron (μ [the Greek letter mu])	0.001 millimeter (exactly). 0.000 039 37 inch (exactly).
1 mil	0.001 inch (exactly). 0.025 4 millimeter.
1 mile (mi) (statute or land)	5 280 feet. 1.609 kilometers.
[1 mile (mi) (nautical, geographical, or sea, U. S.)].[10]	1.152 statute miles. 6 080.20 feet. 1.853 kilometers. 1.001 international nautical mile.
1 mile (mi) (nautical, international)[10]	1.852 kilometers (exactly). 6 076.10 feet. 1.151 statute miles. 0.999 U. S. nautical miles.
1 millimeter (mm)	0.039 37 inch (exactly).
1 millimicron (mμ [the English letter m in conjunction with the Greek letter mu])	0.001 micron (exactly). 0.000 000 039 37 inch (exactly).
1 point (typography)	0.013 837 inch (exactly).[11] 0.351 millimeter.
1 rod (rd), pole, or perch	16½ feet. 5½ yards. 5.029 meters.
1 yard (yd)	0.914 meter.

AREAS OR SURFACES

1 acre [12]	43 560 square feet. 4 840 square yards. 0.405 hectare.
1 are (a)	119.596 square yards. 0.025 acre.
1 hectare (ha)	2.471 acres.

[10] *See* Table of Linear Measure, p. 181.
[11] This value is nearly 1/72 inch.
[12] A square 208.710+ ft on a side has an area of 1 acre.

[1 square (building)]	100 square feet.
1 square centimeter (cm^2)	0.155 square inch.
1 square decimeter (dm^2)	15.500 square inches.
1 square foot (sq ft)	929.034 square centimeters.
1 square inch (sq. in.)	6.452 square centimeters.
1 square kilometer (km^2)	247.104 acres. 0.386 square mile.
1 square meter (m^2)	1.196 square yards. 10.764 square feet.
1 square mile (sq mi)	259.000 hectares.
1 square millimeter (mm^2)	0.002 square inch.
1 square rod (sq rd), sq pole, or sq perch	25.293 square meters.
1 square yard (sq yd)	0.836 square meter.

CAPACITIES OR VOLUMES

1 barrel (bbl), liquid	31 to 42 gallons.[13]
1 barrel (bbl), standard, for fruits, vegetables, and other dry commodities except cranberries	7 056 cubic inches 105 dry quarts. 3.281 bushels, struck measure.
1 barrel (bbl), standard, cranberry	5 826 cubic inches. $86\frac{45}{64}$ dry quarts. 2.709 bushels, struck measure.
1 bushel (bu) (U. S.) (struck measure)	2 150.42 cubic inches (exactly). 1.244 cubic feet. 0.969 British bushel. 35.238 liters. 9.309 gallons.[14]
[1 bushel, heaped (U. S.)]	2 747.715 cubic inches. 1.278 bushels, struck measure.[15]
[1 bushel (bu) (British Imperial) (struck measure)]	1.032 U. S. bushels, struck measure. 2 219.360 cubic inches.
1 cord (cd) (firewood)	128 cubic feet.
1 cubic centimeter (cm^3)	0.061 cubic inch.
1 cubic decimeter (dm^3)	61.023 cubic inches.
1 cubic foot (cu ft)	7.481 gallons. 0.804 bushel. 28.317 cubic decimeters.
1 cubic inch (cu in.)	0.554 fluid ounce. 4.433 fluid drams. 16.387 cubic centimeters.
1 cubic meter (m^3)	1.308 cubic yards.
1 cubic yard (cu yd)	0.765 cubic meter.
1 cup, measuring	8 fluid ounces. ½ liquid pint.

[13] There are a variety of "barrels," established by law or usage. For example, Federal taxes on fermented liquors are based on a barrel of 31 gallons; many State laws fix the "barrel for liquids" as 31½ gallons; one State fixes a 36-gallon barrel for cistern measurement; Federal law recognizes a 40-gallon barrel for "proof spirits"; by custom, 42 gallons comprise a barrel of crude oil or petroleum products for statistical purposes, and this equivalent is recognized "for liquids" by four States.

[14] This is a mathematical equivalent, useful only in correlating units of liquid and dry measure.

[15] Frequently recognized as 1¼ bushels, struck measure.

1 dram, fluid (or liquid) (fl dr or ƒ ʒ) (U. S.)	⅛ fluid ounce. 0.226 cubic inch. 3.697 milliliters. 1.041 British fluid drachm.
[1 dram, fluid (fl dr) (British)]	0.961 U. S. fluid dram. 0.217 cubic inch. 3.552 milliliters.
1 dekaliter (dkl)	2.642 gallons. 1.135 pecks.
1 gallon (gal) (U. S.)	231 cubic inches. 0.134 cubic foot. 3.785 liters. 0.833 British gallon. 128 U. S. fluid ounces. 0.107 U. S. struck bushel.[16]
[1 gallon (gal) (British Imperial)]	277.42 cubic inches. 1.201 U. S. gallons. 4.546 liters. 160 British fluid ounces.
1 gill (gi)	7.219 cubic inches. 4 fluid ounces. 0.118 liter.
1 hectoliter (hl)	26.418 gallons. 2.838 bushels.
1 hogshead (hhd), liquid	63 gallons (two 31½-gallon barrels). 238.476 liters.
1 liter	1.057 liquid quarts. 0.908 dry quart. 61.025 cubic inches.
1 milliliter (ml)	0.271 fluid dram. 16.231 minims. 0.061 cubic inch.
1 ounce, fluid (or liquid) (fl oz or ƒ ʒ) (U. S.)	1.805 cubic inches. 29.573 milliliters. 1.041 British fluid ounces.
[1 ounce, fluid (fl oz) (British)]	0.961 U. S. fluid ounce. 1.734 cubic inches. 28.412 milliliters.
1 peck (pk)	8.810 liters.
1 pint (pt), dry	33.600 cubic inches. 0.551 liter.
1 pint (pt), liquid	28.875 cubic inches (exactly). 0.473 liter.
1 quart (qt), dry (U. S.)	67.201 cubic inches. 1.101 liters. 0.969 British quart. 1.164 U. S. liquid quarts.[16]
1 quart (qt), liquid (U. S.)	57.75 cubic inches (exactly). 0.946 liter. 0.833 British quart. 0.859 U. S. dry quart.[16]

[16] This is a mathematical equivalent, useful only in correlating units of liquid and dry measure.

[1 quart (qt) (British)]	69.354 cubic inches. 1.032 U. S. dry quarts. 1.201 U. S. liquid quarts.
1 tablespoon	3 teaspoons.[17] 4 fluid drams. ½ fluid ounce.
1 teaspoon	⅓ tablespoon.[17] 1⅓ fluid drams.[17]

WEIGHTS OR MASSES

1 assay ton [18] (AT)	29.167 grams.
1 carat (c)	200 milligrams. 3.086 grains.
1 dram, apothecaries (dr ap or ℨ)	60 grains. 3.888 grams.
1 dram, avoirdupois (dr avdp)	27 11/32 (=27.344) grains. 1.772 grams.
gamma, *see* microgram	
1 grain	64.799 milligrams.
1 gram (g)	15.432 grains. 0.035 avoirdupois ounce.
1 hundredweight, gross or long [19] (gross cwt)	112 avoirdupois pounds. 50.802 kilograms.
1 hundredweight, net or short (cwt or net cwt)	100 avoirdupois pounds. 45.359 kilograms.
1 kilogram (kg)	2.205 avoirdupois pounds.
1 microgram (μ g [the Greek letter mu plus the letter g])[20]	0.000 001 gram.
1 milligram (mg)	0.015 grain.
1 ounce, avoirdupois (oz avdp)	437.5 grains (exactly). 0.911 troy or apothecaries ounce. 28.350 grams.
1 ounce, troy or apothecaries (oz t, or oz ap, or ℥)	480 grains. 1.097 avoirdupois ounces. 31.103 grams.
1 pennyweight (dwt)	1.555 grams.
1 point	0.01 carat. 2 milligrams.
1 pound, avoirdupois (lb avdp)	7 000 grains. 1.215 troy or apothecaries pounds. 453.592 grams.
1 pound, troy or apothecaries (lb t or lb ap)	5 760 grains. 0.823 avoirdupois pound. 373.242 grams.

[17] The equivalent "1 teaspoon=1⅓ fluid drams" has been found by the Bureau to correspond more closely with the actual capacities of "measuring" and silver teaspoons than the equivalent "1 teaspoon=1 fluid dram" which is given by a number of dictionaries.

[18] Used in assaying. The assy ton bears the same relation to the milligram that a ton of 2 000 pounds avoirdupois bears to the ounce troy; hence the weight in milligrams of precious metal obtained from one assay ton of ore gives directly the number of troy ounces to the net ton.

[19] The gross or long ton and hundredweight are used commercially in the United States to only a very limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

[20] The Greek letter gamma (γ) is also used as a symbol for "microgram."

1 scruple (s ap or ℈)	20 grains. 1.296 grams.
[1 stone (British)]	14 avoirdupois pounds.
1 ton, gross or long [21] (gross tn)	2 240 avoirdupois pounds. 1.12 net tons (exactly). 1.016 metric tons.
1 ton, metric (t)	2 204.622 avoirdupois pounds. 0.984 gross ton. 1.102 net tons.
1 ton, net or short (tn or net tn)	2 000 avoirdupois pounds. 0.893 gross ton. 0.907 metric ton.

[21] The gross or long ton and hundredweight are used commercially in the United States to only a very limited extent, usually in restricted industrial fields. These units are the same as the British "ton" and "hundredweight."

U. S. GOVERNMENT PRINTING OFFICE: 1955